JANUARY, 1936

Engineering and Mining Journal

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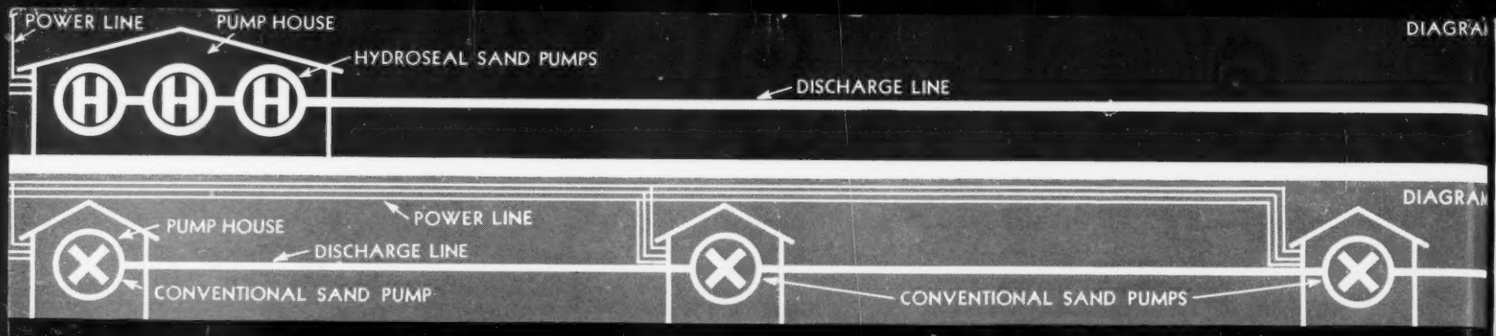

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Published by McGraw-Hill Publishing Co., Inc.

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Vice-President

Next Month we publish our annual survey and outlook number. It will include an exclusive feature of international interest presented in a wholly novel manner comprising a series of world maps showing production, apparent consumption, and international flow of twelve major ores and metals. Almost at a glance the reader will comprehend the international trade relations in these commodities. In addition there will be authoritative statements on the principal metals, trends in mining, metallurgy, and equipment, and regional reviews of mining in the principal countries of the world. *E.&M.J.'s* metal-price chart and metal statistics will round out an annual number of unusual value to the mining industry.

*

Platinum Group. Canada is now producing on a commercial scale five of the six precious metals in the platinum group, according to the International Nickel Company. They are platinum, palladium, iridium, rhodium, and ruthenium. All are found in the nickel-copper ores of the Sudbury basin district. Osmium, the remaining platinum metal, is not produced in Canada.

*

Popular Interest in gold mining is indicated by the fact that the University of Southern California, Los Angeles, is offering a non-technical course in the subject. Object: To familiarize laymen with the elements of gold mining and arouse intelligent interest in the industry. Instruction will cover the subject from prospecting to management, and will be given by Julian Boyd, local consulting mining engineer.

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Speaking of Bosses, G. T. Geringer, Philippine mining engineer, makes the following heartfelt comment in the *Baguio Bulletin* regarding novice executives: "Difficulties multiply for the engineer whose employer is non-technical. His position will be very much easier if his untrained employer happens to be one who can place a peso on a bet and lose with his heart smiling in sympathy with his lips. Briefly stated, a boss who is a good gambler, be he an engineer or not, is one of the best under which a tough job can be done. In contrast to the gambler boss, is the novice employer of engineers who craves a million but who quakes in betting a dime. These men are the mining engineers' nightmare."

*

Woman's Right (or is it a privilege?) to do underground mining work in India has been challenged by the League of Nations and the European owners of Indian mining properties. Native owners of mines fear "dislocation of labor should abolition be enforced too hastily." Nevertheless, the 12,799 women who, according to the latest record, were doing underground mining in India must find other employment by July, 1939. As the women miners must be replaced by men, production should exhibit no curtailment.

*

The Year 1936 marks the 70th anniversary of the publication of *Engineering and Mining Journal. Metal and Mineral Markets,* its weekly market-news service, celebrates in 1936 the completion of its sixth year of publication. To all whose support and approval have made possible the old and the new record, felicitations for the new year and a pledge of continued service and cooperation.

ENGINEERING AND MINING JOURNAL is published monthly by the McGraw-Hill Publishing Company, Inc., 330 West 42d St., New York, N. Y., U. S. A. Subscription rates, United States and Canada, $3 per annum; other countries in the Americas outside the United States and Canada, $4 per annum; elsewhere $5 or 20 shillings per annum. Price per copy 50c. or 2s. Entered as second-class matter June 20, 1879, at the Post Office, New York, N. Y., under the act of March 3, 1879. Printed in U. S. A.

McGRAW-HILL PUBLISHING COMPANY, INC.
330 West 42d Street, New York, N. Y.
Cable Address: McGraw-Hill, N. Y.
San Francisco: 883 Mission Street
Chicago: 520 North Michigan Avenue
Washington, D. C.: National Press Building

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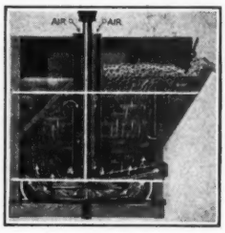
McGRAW-HILL PUBLISHING COMPANY, LTD.
Aldwych House, Aldwych,
London, W.C.2, England
Cable Address: Backlash, Estrand, London

Printed by The Schweinler Press, N. Y.

10 REASONS WHY THE DENVER "SUB-A" FILLS ALL FLOTATION REQUIREMENTS

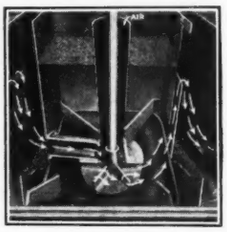
1. Denver "Sub-A" Operation

Denver "Sub-A" Cells have three zones; in bottom zone, impeller thoroughly mixes and aerates the pulp; the central zone separates the mineral laden particles from the worthless gangue, and in top zone the mineral laden concentrate, high in grade, is quickly removed by the paddle of a Denver "Sub-A" Cell.



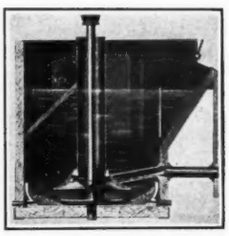
2. Positive Cell Circulation

In the Denver "Sub-A" (Fahrenwald) Flotation Machine, the *gravity flow* method of circulating pulp is distinctive. There is no short circuiting through the machine. Every cell must give maximum treatment, as pulp falls on top of impeller and is aerated in each cell repeatedly. Note *gravity flow* from cell to cell.



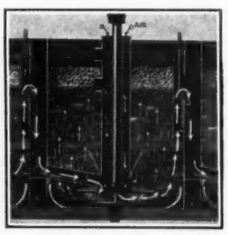
3. Choke-Ups Are Eliminated

A Denver "Sub-A" Cell will not choke-up, even when material as coarse as ¼" is handled, due to the *gravity flow* principle of circulation. After a shutdown it is not necessary to drain the machine, as the stationary hood protects impeller from sanding up. See illustration at right showing Cell when shut down.



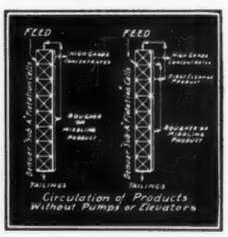
4. No Blowers Are Needed

No air under pressure is required with Denver "Sub-A" Cells, as sufficient air is drawn down the stationary standpipe. The expense and complication of blowers, air pipes and valves are thus eliminated. The standpipe is a vertical air duct which gives direct passage of air to the heart of the Cell, the impeller.



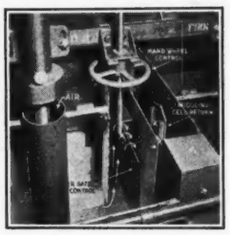
5. Denver "Sub-A" Flexibility

Any Denver "Sub-A" Cell can be used as a rougher, cleaner or recleaner. Rougher or middling products can be returned to the front or back of any cell *by gravity* without the use of pumps or elevators. Cells can be easily added when required. This flexibility is most important in operating flotation mills.



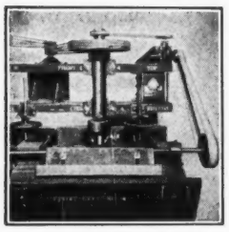
6. Pulp Level Is Controlled

Every Denver "Sub-A" Flotation Cell is actually an individual machine with its own pulp level easily controlled by weir overflow. The hand wheel, which controls the exact height of the pulp level in each Cell, is easily reached and can be immediately raised or lowered by operator; important for efficiency.



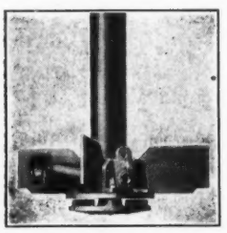
7. High Grade Concentrate

The quick removal of the mineral froth in the form of a concentrate increases the recovery. By having an adjustable paddle for each Denver "Sub-A" Cell, quick removal of concentrate is assured. Note unit bearing housing for the impeller shaft and speed reducer drive which operates the paddle for each Cell.



8. Fewer Wearing Parts

Denver "Sub-A" Cells are built for long, hard service, and parts subject to wear are easily replaced at low cost. Molded rubber wearing plates and impellers are light in weight, give extra long life, and lower horsepower. These parts are made under exact specifications and patented by Denver Equipment Co.

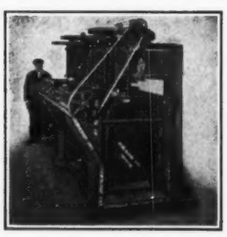


9. Lowest In Horsepower

The Denver "Sub-A" was the first flotation unit equipped with "V" belts. The actual horsepower per ton treated is the lowest of any flotation machine, considering high recovery and grade of concentrates produced. This "V" type of drive is foolproof and makes it easy to change speed of the impeller shafts.

10. Rugged Construction

There is no machine so rugged or so well built as the Denver "Sub-A" (Fahrenwald) Flotation Machine. Note the heavy channel iron supports, bents, and tank (made of wood or steel). Denver "Sub-A" (Fahrenwald) Flotation Cells are internationally known as *"the lowest cost units per ton of capacity."*



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Volume 137 JANUARY 1936 Number 1

The Riddle of Silver

FOR THE FIRST TIME since 1914, silver was without quotation on the London market on December 10, 1935, coincident with the withdrawal of the United States Treasury from that market. The world price immediately sagged and has since declined from 29 3/16d. London, or 65 3/8c. New York, to 22 1/2d. and 49 3/4c., respectively, on December 31. As with one voice the financial world asked "Whither silver?" and raised its collective eyebrows in the direction of Washington.

Rumor was rife, and comment was critical and caustic. Hostile political writers attacked the Administration for the folly of its silver purchase policy, and pointed to disastrous effects on the financial affairs of China. Secretary Morgenthau denied any fundamental change in policy, quoting the law authorizing him to buy silver "upon such terms and provisions as he may deem reasonable and most advantageous to the public interest," and maintained his adherence to the general program. At the same time he revealed that up to the close of business on December 6 he had acquired 761,774,000 ounces of silver; 113,031,000 under the nationalization order of August 9, 1934; 56,943,000 newly mined domestic metal in accordance with the President's proclamation of December 21, 1933; and 591,800,000 under the Silver Purchase Act of June 19, 1934.

But if the Treasury's policy is unaltered, certainly its plan of action has been radically changed, presumably to one that is more "advantageous to the public interest." Undoubtedly it results from the Treasury's inside knowledge of events in the Far East, and uncertainty regarding the monetary policy of the Chinese Government with respect to silver. Should her program for a managed currency, tied to sterling rather than to the dollar, result in the abandonment of silver, several hundred million ounces of the metal might be dumped onto the market, in which the United States is almost the sole buyer. In fact, the smuggling of silver out of China to escape the nationalization decree and take advantage of speculative profits had already disturbed the market and given a foretaste of what might happen on a grand scale. As a prudent purchaser the Treasury was justified in withdrawing from the market, at least temporarily, until conditions became more stable.

The Treasury's future plan of action remains unrevealed. Secretary Morgenthau has intimated that he will continue to buy silver, but for the present chiefly current production from the United States and possibly other silver-producing countries like Mexico. Silver bloc Senators have expressed confidence in the Treasury's actions and in the ultimate success of the plan to establish silver as part of the metallic base of the national currency. Undoubtedly, when the Administration embarked on its silver program it hoped for subsequent international acceptance of silver as a monetary metal in some future plan for stabilizing world currencies. Probably we are witnessing an age-old struggle in new guise, with silver still in the lap of the political gods.

The domestic situation is our own affair, but it is not without its problems. Silver producers are beneficiaries of the Government's monetary policies. They are receiving 77.57c. an ounce for current production, which is at least 12c. above the recently prevailing world price. Although it is quite possible that the Treasury did not intend immediately to peg so high a price, there is no suggestion that it will be reduced. Some millions of additional dollars have thus been added to the income of United States silver producers. Production for 1935 will be of the order of 38 to 40 million ounces, and the bonus will be at least upwards of five million dollars, reckoned on the recent world price. But silver production is not without minor incidence on base-metal markets, and one of the problems of the domestic silver producer is to avoid depressing those markets by excessive production merely in order to enjoy a high price for his silver byproduct.

Detachable Bits Demonstrate Economy in Comparative Tests

DETACHABLE BITS for rock drilling have gained sufficiently wide acceptance in the mining industry during the past few years to demonstrate their utility and economy under a variety of conditions. Comparative tests with bits forged on the drill rod have usually yielded conclusive evidence in favor of the detachable type. New testimony is now added to the growing mass of data as a result of a series of tests conducted by the Tennessee Valley Authority at a dolomite quarry at Norris Dam. An abstract of the engineer's report is published in this issue.

Five tests were recorded, each lasting one month. The first and fifth were on forged bits, regular equipment on the job, but under different conditions in the

quarry. Each of the second, third, and fourth was on one of three makes of detachable bits. Performance and cost data of the latter group are consolidated in our tabulation of test records in order to facilitate general comparison with forged bits.

Briefly summarized, detachable bits proved more economical than forged bits, showing a higher drilling rate in feet per hour and a lower cost in cents per foot. Transportation and handling of steel, always a substantial item of cost, was favorable to detachable bits—an advantage that would be accentuated in underground mines with extensive workings.

No investigation was made of the metallurgical characteristics of drill rod or bits. This is a line of research that should be pursued by the manufacturers because it offers the best avenue toward improvement of drill steel. The very nature of the detachable bit makes possible the selection of steel and its alloys best suited to the special requirements of the drill rod and the cutting head.

Coating Metals With Aluminum

PATIENT and painstaking research usually brings results. Almost always some way can be found to achieve a desired end. And so it is not surprising that so brilliant a research metallurgist as Dr. Colin G. Fink, of Columbia University, has devised a method for putting a coating of aluminum on ferrous metals. "Aluminum plate" thus becomes a new industrial commodity, comparable with tin plate, competitive with it, and superior to it in some respects. Which reminds us that research is a most effective weapon in combating the arbitrary policies of artificially controlled industries, like the tin pool, that fix prices for their products. Unwittingly they invite research for competitive substitutes.

In Dr. Fink's process the metal to be coated is suitably prepared and introduced into a molten aluminum bath. An alloy bond of aluminum and iron is formed at the surface of the article to be coated. The process can be adapted to the continuous treatment of wire, rods, bars, beams, and sheets, such as may be required for the fabrication of metal products. The resulting surface is smooth, bright, and dense.

The crux of the process is in the preliminary treatment of the ferrous metal. Wire, for example, is first pickled in a cleaning solution, then heated to redness and passed through a solution of boric acid or borax. It is then introduced into a hot chamber containing hydrogen for deoxidation. The surface of the wire becomes charged with hydrogen, which serves as an important "fluxing agent" during the initial formation of the alloy bond between the coating and the base metal. From the furnace the wire passes into a molten bath of aluminum, from which it is drawn and wiped while the coating is still plastic, to remove surplus metal and regulate the thickness of the deposit. The process is in commercial use, and products will soon be available for industrial application.

Industrial Conference Fails to Function

SHORTLY after the Supreme Court shelved the NRA the President appointed Major George L. Berry Coordinator for Industrial Cooperation. In private life Major Berry is president of a powerful and influential trade union. Little was heard of his public activities until he called an "industry conference" to convene in Washington to consider "the best means of accelerating industrial recovery, eliminating unemployment, and maintaining business and labor standards." It was intended that groups representing management and labor in different industries should meet for separate round-table discussions, express their views, and appoint delegates to a "council of industrial progress" that would attempt to formulate a program out of the mass of material submitted.

Appraising its performance thirty days after the event it is clear that the conference fell far short of its promise to unite management and labor in a constructive program for the solution of the country's economic problems. As a matter of fact it was ill-starred from the beginning. None but the blindest optimist could have imagined that industry's managers would attend a meeting with so indefinite a program and such nebulous objectives as had been announced. In the background was lack of confidence in the Coordinator and a haunting suspicion that in some way or other industry would be entangled in plans with which it had no sympathy. So the conference flared brilliantly for a brief moment, faded and died, and is even now in the limbo of forgotten things.

As was to be expected, organized labor was in attendance as fully as management was absent. And we may yet see the conference used as a sounding board to reflect to Congress labor's views on the 30-hour week, standards of wage rates, federal licensing of corporations engaged in interstate commerce, establishment of a national industrial council, and other forms of federal regimentation that are not only obnoxious but futile as means of industrial recovery.

Management and labor still have diverse points of view despite their obvious common interests. But their mutual problems will not be solved in the grand manner attempted by Major Berry. Rather will they be met by the slower process of education resulting from sincere discussion in small industrial units where a feeling of confidence is more likely to prevail.

HISTORICAL SUMMARY: ENGINEERING AND MINING JOURNAL was founded in 1866 as the *American Journal of Mining*, the title being changed in 1869. Publications with which *Engineering and Mining Journal* has been consolidated comprise: *Coal and Iron Record* (1875); *The Mining Review* (1877); *The Polytechnic Review* (1879); *Mining and Metallurgy* (1902); *The Mining Magazine* (1906); *Mining and Engineering World* (1917); *Mining and Scientific Press* (1922); *Engineering and Mining World* (1932) . . . . THE FOLLOWING have served as editors in chief of *Engineering and Mining Journal* and its predecessor publications: G. F. Dawson (1866-67); R. W. Raymond (1867-74); R. W. Raymond and R. R. Rothwell (1874-89); R. P. Rothwell (1890-1901); D. T. Day (1901-02); T. A. Rickard (1903-05); W. R. Ingalls (1905-19); J. E. Spurr (1919-27); A. W. Allen (1927-33); H. C. Parmelee (1933—) . . . . THE EDITORIAL STAFF of *Engineering and Mining Journal* comprises: H. C. Parmelee, editor; A. H. Hubbell, associate editor; H. C. Chellson, W. N. P. Reed, J. B. Huttl, assistant editors; H. H. Wanders, market editor; G. J. Young, consulting editor.

SURFACE BUILDINGS of the Itogon Mining Company in the Philippine Islands. Company mess and staff homes are in the upper right

Itogon

A Philippine Gold Producer

Treats 10,000 tons of ore per month by all-sliming, countercurrent cyanidation, with a recovery that is close to 92 per cent

Ralph Keeler

Baguio, P. I.

ONE OF THE OLDEST gold-mining enterprises in the Baguio district of the Philippine Islands is the Itogon Mining Company. Its property consists of 80 claims containing 660 hectares in the subdistrict of Itogon, Mountain Province, about 190 miles northwest of Manila and 17 miles from Baguio, at an elevation of 4,000 ft. The company was organized in 1924. J. H. Marsman is president. A mine management contract was signed with Marsman & Company, of Baguio, on Oct. 1, 1934, since which date that company has been operating Itogon.

In 1926 a 30-ton mill was placed in operation. This has been enlarged by subsequent steps, including rebuilding in 1934 and changing from a slime-and-sand treatment to an all-sliming, countercurrent process, followed in 1935 by the installation of a coarse-crushing plant, until today its capacity is 10,000 tons per month. Construction of more tank space now in progress will raise this figure to 11,000 tons. Figures for Itogon, given in Table I, show its growth since operations first began.

Three major vein systems have been developed, and in order of importance are known as the Taka-Bar lode, Sesame, and 96 systems. The veins are of the fissure type, consist of quartz and calcite, and are contained in various phases of diorite which have been intruded by numerous pre-mineral andesite dikes. They vary in width from 18 in. to as much as 25 to 30 ft., and are the continuation of, and the same as, those being worked by the Balatoc Mining Company.

The deposition of commercial ore values has been remarkably uniform throughout the vein sections, and over 80 per cent of the vein areas so far developed have proved productive. The average grade of the ore treated at Itogon, however, is considerably lower than that of Balatoc.

The best grade of ore in the mine is situated directly on the side line between Itogon and Balatoc. It drops in grade in an easterly direction, until at a point east of the present vertical shaft it becomes too poor to mine.

The figure of $7.88 per ton, for 1934, which is $1.07 lower than that of 1933, is a striking example of the fact that the increased price of gold has enabled the operators to work a lower grade of ore, thereby increasing the tonnage available for mining, rather than taking the $35 price for increased profits.

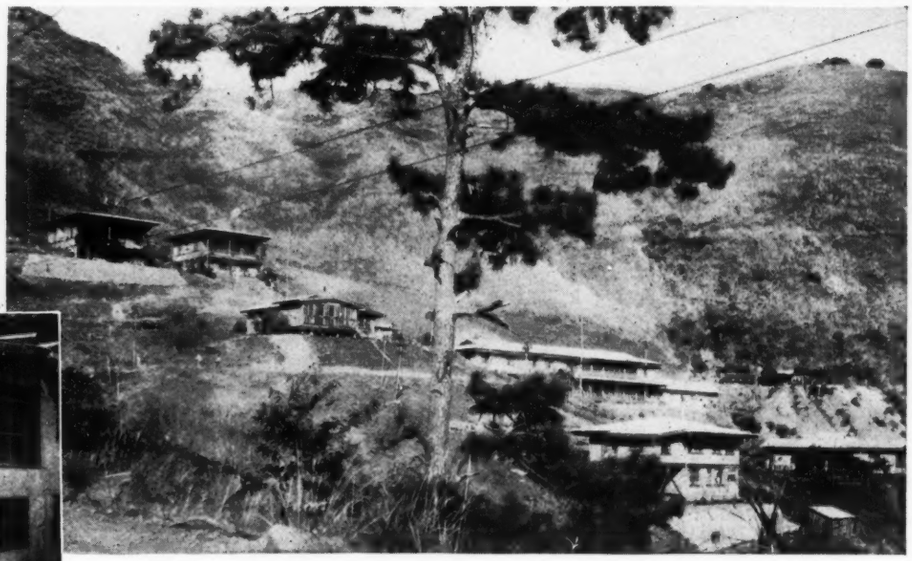
From the start of operations to the end of 1934 approximately 79,000 ft. of development work was driven. The tonnage milled has been 372,593, and positive ore reserves on Jan. 1, 1935, were 307,420 tons, with a total value of $3,448,021. These figures include only ore above the 1,450 level.

Itogon has from the very beginning of operations been faced with the problem of making a profitable production from ore ranging in grade from that definitely low to border-line ore. This has been accomplished by careful arrangement and supervision of details.

Four American mine shift bosses and a number of native bosses, or *"capatazes,"* are in direct control of operations. In mining the low-grade Itogon ore, the systematic training of the *capatazes* in improved operating methods and in the careful mining of the ore in the stopes has been stressed, as well as safety-first routine. Each stope *capataz* must be informed at all times of the assay values in each face being worked. As much waste as possible is sorted out in the stope, and sections of the vein which are too low grade to mine are either blasted for fill or allowed to stand as pillars.

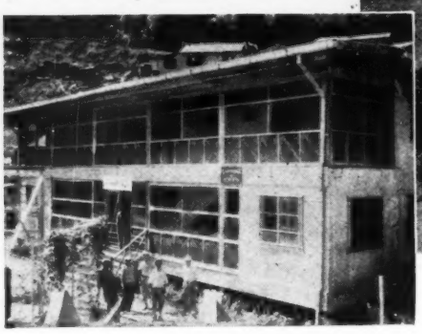
A thorough system of sampling is pursued as routine procedure, in which every working face and stope is sampled every 24 hours. These assay results are available daily before the night shift goes on and are also posted underground at the points where the samples were taken, so that the following shift can direct the mining of ore on the basis of known values.

The record of tons and values pro-



RESIDENCE SECTION for the Itogon staff. The mess and club building is the large structure in the center, the other houses being the quarters of married engineers. This site is about a kilometer above the plant

THE ITOGON HOSPITAL. A resident physician and graduate trained nurse are always in attendance at the plant. Twenty-six persons can be accommodated here



duced from every raise, drift, and stope is posted daily in the mine office, and when the grade falls below $4 on the $20.67 basis, the figures are marked in red, resulting in an immediate investigation of those places. Development advance is measured daily in all faces, and, consolidated with other important operating figures, is posted daily in the mine office.

The mine is operated through nine levels and a three-compartment vertical shaft, the collar of which is located near the portal of No. 2 level at the mill-bin elevation. All ore coming from below No. 2 level is hoisted through the shaft and ore from above No. 2 level is delivered to the mill by gravity.

The shaft is equipped with a steel headframe 110 ft. high and is serviced by a double-drum 75-hp. Washington Iron Works hoist with rope speed of 400 ft. a minute. An average delivery of 250 tons in Gregg 1-ton cars can be hoisted per shift, in addition to the usual shaft requirements of handling men and supplies. The shaft now serves No. 1 level, 1,300 level, 1,400 level, and the 1,650 level. From the collar to the 1,650 level is 500 ft. This three-compartment shaft is being deepened at present, and has reached the 1,775-ft. elevation. Work of sinking will be continued until the drain tunnel is reached, some 870 ft. below the 1,650 station. The drain tunnel will be driven in from the lower river elevation, a distance of 6,000 ft., to connect with the shaft.

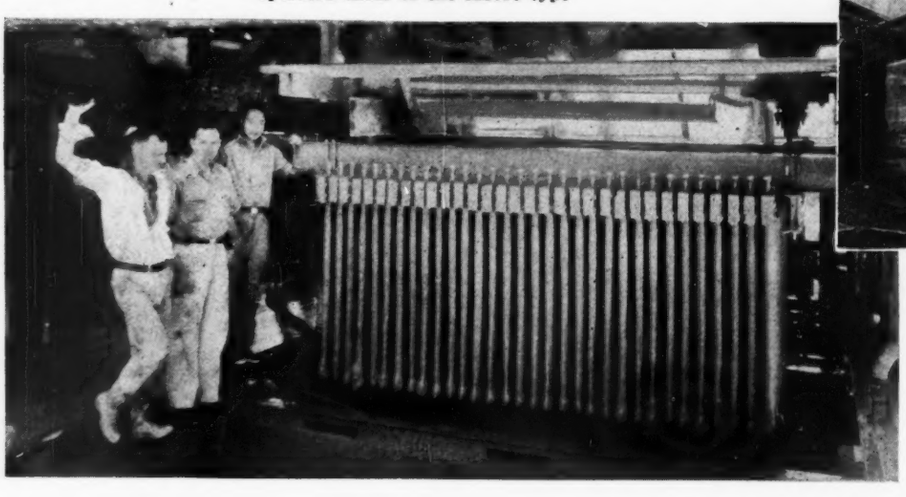
The shaft signal system is of the interlocking bell and light spotting type, was designed by F. W. Tuck, of Benguet Consolidated, and is operated in conjunction with the Lilly hoist-control equipment. This equipment was constructed and the shaft placed in operation during 1934.

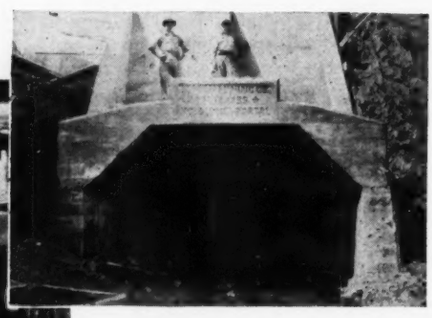
The Taka-Bar lode vein has been stoped more or less continuously along its lateral extent for a distance of some 3,000 ft., to the Balatoc end line, and over a vertical extent of 700 ft. The Sesame vein system is being reopened after having been abandoned, and is now being developed by three headings, the No. 3 level, 1,400 level, and 1,600 level.

Methods of stoping vary with the ground, and include cut-and-fill, square-set, stull-and-headboard, and, in a few areas, shrinkage stoping. Raises are driven at 50-ft. intervals and the rill type of stope is used wherever possible. Instead of the usual 8x8-in. or 10x10-in. timbers, 6x6-in. timbers are used in the stopes requiring square-set and fill methods. This effects a considerable saving, but also necessitates very close attention by division bosses and prompt filling as soon as a floor is clear, as the sets usually show considerable strain as the next upper floor is cut.

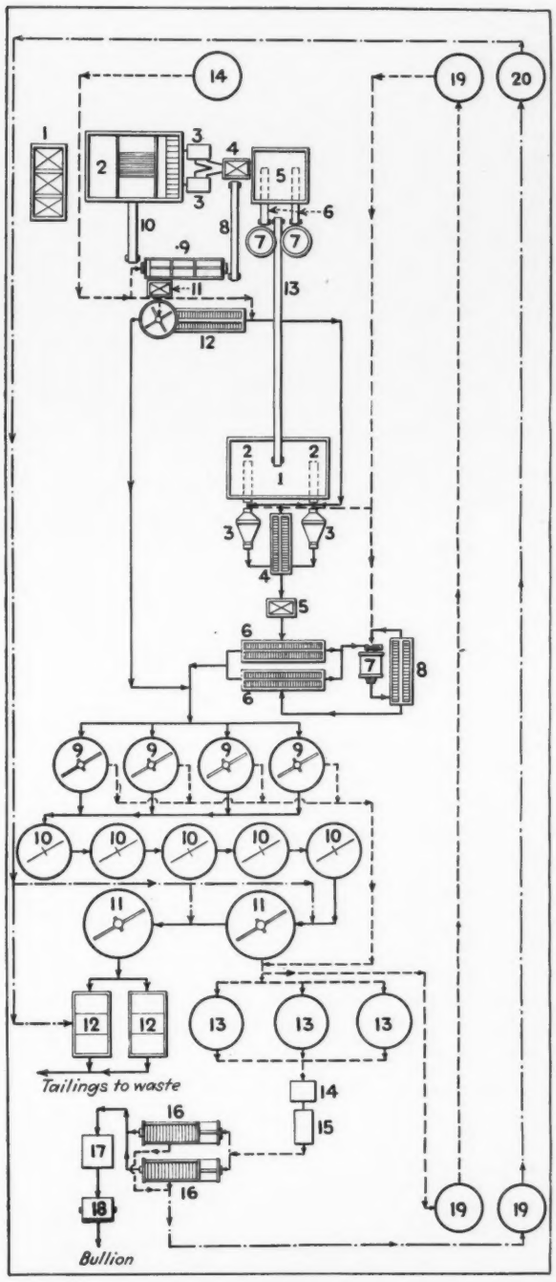
In cut-and-fill and square-set stope preparation, raises are driven at 50-ft. intervals for filling. As the vein filling is ordinarily incapable of self-support

THE FILTERS undergo inspection. Practice here differs from that elsewhere in the district in that filtering is done with two electrically and hydraulically operated units of the Moore type





PORTAL of No. 2 tunnel, the main haulageway at Itogon. Near by is the collar of the three-compartment shaft, in which all ore from below is hoisted. Ore from above this point is delivered by gravity. The mine is opened on nine levels



FLOWSHEET of the Itogon Mining Company's all-sliming countercurrent cyanidation plant, near Baguio, P. I. Formerly treating both sands and slimes, the mill was rebuilt in 1934 to use the process here outlined. In drawing this flowsheet, some simplification has been used

LEGEND

CRUSHING PLANT

1. Three-compartment shaft
2. 700-ton ore bin
3. No. 11A Telsmith crushers
4. Link-Belt bucket elevator
5. 200-ton surge bin
6. 24-in. conveyors
7. 3-ft. Simons cone crushers.
8. 18-in. conveyor
9. Telsmith Hercules washer
10. 24-in. conveyor
11. Wet elevator
12. 9-ft. bowl Duplex Dorr classifier
13. 18-in. conveyor to mill ore bin
14. Mill solution tank

MILLING PLANT

1. 500-ton fine-ore bin
2. 16-in. conveyors
3. 6-ft.x22-in. Hardinge ball mills
4. Dorr Duplex Model 7 classifier
5. Wet elevator
6. Dorr Duplex classifiers
7. 5x5-ft. Eimco ball mill
8. Dorr Duplex classifier
9. Four 25x9-ft. Dorr thickeners
10. Five 25x20-ft. Dorr agitators
11. Two 34x12-ft. Dorr thickeners
12. Two Moore filter units
13. Three sand classifiers
14. Clarified-solution tank
15. Crowe Merrill vacuum unit
16. Two Merrill precipitation presses
17. Precipitate dryer
18. Denver fireclay No. 275 melting furnace
19. 25x10-ft. mill-solution tank
20. 25x10-ft. barren-solution tank

AT THE FACE. Working these two jackhammers is a crew of Igorot miners. Although this view was taken during the dry season, considerable water was present, necessitating the use of boots

STEEL HEADFRAME, 110 ft. high, of three-compartment shaft through which all ore coming from below No. 2, or main haulage, level is hoisted to the surface in 1-ton cars on cages. This shaft is now 1,775 ft. deep

LOADING A CAR. These miners are typical of the labor at Itogon and the other properties in the Baguio district. Slight and short, they are not exceptionally strong, several of them being needed to do the work of an American miner

for any length of time, no level pillars are left, but stoping starts immediately above the drift sets, which are spaced 5 ft. center to center, with single caps, except in a few instances in very heavy ground, where double caps are used. Waste for fill is secured from two direct waste passes to surface glory holes, one in the central area of the orebody and the other near the west property line. Whenever it is possible to abandon old workings above, fill from old mined-out areas is pulled and re-used. At present fill from this source constitutes about 50 per cent of the total required.

The re-use of old fill is especially desirable during the rainy season, when much difficulty is experienced in handling the large quantities of water that flows down the general waste passes. Each waste pass is provided with a bulldozing chamber, the arrangement of which is such that the grizzly may be easily bulkheaded over and the water bypassed out of the mine. This is done upon receipt of warning of the approach of a typhoon, when exceedingly heavy and steady rainfall may be expected for at least three or four days.

All mining is carried on by machine rock drills. A 3-ton Jeffrey storage-battery locomotive with 30-cu.ft. Benguet-type Gregg cars is used for hauling on the 1,650 level; the tramming on all other levels is done by hand in 1-ton cars. Two waste raise systems are used, one in the central section and one in the west section of the mine, to deliver surface material as fill for the stopes. Two Eimco air shovels are giving satisfactory service in mining operations.

About 125,000 board feet of lumber are delivered each month, of which some 100,000 ft. are used for general mining purposes. This timber is cut from the Itogon concessions under contract with the Heald Lumber Company, and is delivered over an aërial tramway 2 km. long.

The mine department employs 750 men.

Mine costs average around $1.94 a ton. Figures for a typical month of 1935 are given in Table II.

A very complete system has been installed in the distribution and checking of labor and supplies. Daily *capataz* reports of work accomplished are carefully checked by division bosses. All supplies used in the mine must be requisitioned by a division boss or the mine superintendent. Underground supply *bodegas,* close to the important divisions of work and connected by telephone to the mine office, have added greatly to increased efficiency. Machine-drill records showing the individual cost of repairs and a work record of each drill shift have assisted in keeping the equipment in proper repair and increased the work performed per drill shift.

Increased use of small air hoists in getting supplies into the stopes has helped to lower cost. Maintenance of main manways with offset ladders and platforms has made for safer operation and communication. The use of hard-boiled hats has in the past year saved several lives, and all men working in shaft and winzes must wear them. This policy is being extended to include all men underground.

Closer attention to major ventilation matters and the more frequent installation of blower units for adits and drifts have increased labor efficiency. Use of compressed-air driven fans is most serviceable where long electric wire connections would have been required.

Milling at Itogon

The Itogon mill now has a capacity of 10,000 tons a month. During 1934, as previously stated, it was changed from a sand and slime plant to an all-sliming counter-current treatment.

Chemically, the Itogon ore is ideal for cyaniding. Part of the gold is associated with pyrite, but most of it is free and very finely divided. The part associated with pyrite is easily made accessible to cyanide solutions by fairly fine grinding. At present the ore is ground to about 65 per cent minus 200 mesh. A finer product would give a better recovery, but with the present plant the decrease in tonnage to accomplish finer grinding would materially lower over-all production.

Ore is delivered in 1-ton end-dump cars, and dumped on to an inclined-

Table I—Gold Production, Tonnage Milled and Value Recovered—Itogon Mining Company, 1925 to June 1, 1935

	Gold Production	Tonnage Milled	Value Recovered per Ton
1926	$14,005	2,960	$4.75
1927	105,962	13,310	7.90
1928	208,922	19,347	10.80
1929	207,157	24,024	8.60
1930	232,392	22,045	10.18
1931	417,314	50,918	8.20
1932	622,148	69,878	8.91
1933	827,760	75,111	8.95
1934	1,096,269	95,114	7.88
1935 (First six months)	577,870	56,441	*10.24

*New price of gold and silver.

Table II—Mine Costs

Mine stoping	$1.22
Operating development	0.37
Mine general expenses	0.35
	$1.94

The above costs are distributed as follows:

Mine Stoping (per Ton)

Breaking	$0.42
Mucking	0.09
Filling	0.175
Timbering	0.29
Tramming	0.11
Hoisting	0.05
Engineering	0.01
Assaying	0.07
	$1.22

Development (Cost per Foot)

Breaking	$3.49
Mucking and Tramming	0.26
Timbering	0.76
Hoisting	0.11
Engineering	0.185
Assaying	0.15
Ventilation	0.015
	$4.97

or, $0.37 a ton for the month taken

Mine General Expenses

Repairs to mine openings	$0.31
Mine office	0.02
Mine miscellaneous	0.02
	$0.35

Table III—Recovery and Tailing Loss

	Average Recovery, Per Cent	Average Tailing Value
Sand and sliming plant	85.5	$1.12
All-sliming plant	92.0	0.60

Table IV—General Costs

Mine costs	$1.94
Mill costs	0.95
Miscellaneous operating expense	0.52
Total mine and mill operating	$3.41
General expense (taxes, insurance, marketing)	0.60
Total operating expense	$4.01

Table V—Direct Operating Costs, Mill Departments

	Cost Per Short Dry Ton of Ore
Coarse crushing	$0.09
Washing-plant operation	0.04
Fine crushing	0.04
Primary grinding	0.23
Secondary grinding	0.06
Thickening	0.03
Agitating	0.03
Precipitation	0.06
Filtering	0.08
Refining	0.02
Assaying	0.04
General miscellaneous	0.06
Extraction, chemicals, etc.	0.17
Total	$0.95

These costs are subdivided as follows:

Labor	$0.20
Supplies	0.40
Supervision	0.12
Power	0.20
Repairs	0.03
Total	$0.95

Table VI—Screen Analysis

	No. 1 Classifier Overflow	No. 2 Classifier Overflow	No. 3 Classifier Overflow	Moore Filter Tailings
Plus 60 mesh	23.80	.....	.....	.....
Plus 100 mesh	19.40	5.60	20.03	17.15
Plus 150 mesh	10.12	8.80	16.02	8.18
Plus 200 mesh	8.65	11.00	13.71	9.79
Minus 200 mesh	38.03	74.60	50.24	64.88

Table VII—Assays of Intermediate Mill Products

Head sample	$6.36
Primary thickener discharge	4.80
No. 1 agitator pulp	2.40
No. 3 agitator pulp	1.90
No. 5 agitator pulp	1.60
No. 5 thickener	1.20
No. 6 thickener	1.05
Moore filter tailings unwashed	0.54
Moore filter tailings unwashed	0.49
Dissolved values loss	0.05
Indicated recovery, per cent	91.40

Table VIII—Consumption of Reagents and Grinding Balls

	Pounds per Ton of Ore
Calcium cyanide	1.2044
Zinc dust	0.0536
Lead acetate	0.0068
Steel balls	1.9970
Lime	3.4063

IGOROT MINERS and women, in native costumes, performing a dance at a "canao," or native feast. The costumes are bright and the dances not unlike those of the American Indians

wedge bar grizzly with bars spaced 3 in. apart center to center. The oversize passes on to a rail grizzly having an 8-in. opening. All pieces larger than 8 in. in diameter are broken by hand and join the plus 2.5-in. material in a bin ahead of the jaw crushers.

Primary crushing is done in No. 11A Telsmith crushers, set to produce a 2-in. product. From these the ore is elevated by a Link-Belt chain and bucket elevator to a 200-ton surge bin. From there the ore is fed by a 24-in. belt conveyor to 3-ft. Symons cone crushers set to give a maximum product of ¾ in. The crushed material drops on to a 16-in. conveyor belt and is conveyed to a 500-ton storage bin ahead of the ball mills.

Undersize from the first grizzly, which contains much clay and primary slimes, is fed to a Telsmith revolving washer. The first section of the washer acts as a scrubber, and the lumps of clay are thoroughly broken up before the ore passes to the screening section. The screens are ¾-in. punched boiler plate. Plus ¾-in. material is diverted to the Symons crusher and the minus ¾-in. to a 9-ft. bowl duplex Dorr classifier. The overflow from the bowl classifier goes directly to the primary thickeners and the rake drag over to the primary ball mills. All washing and screening are done in cyanide solution.

Ore is fed to two 6 ft. by 22-in. primary Hardinge conical ball mills by 18-in.. feeder conveyors equipped with Reeves adjustable speed regulators. These mills are in closed circuit with a Model F duplex Dorr classifier. Classifier overflow is sent to a second classifier, where a finished product is made which goes directly into the slime circuit. The rake-over is sent to a 5x5-in. grate-discharge Eimco ball mill for regrinding. The regrind mill is in closed circuit with a Dorr classifier, which makes a finished product.

Overflow from the bowl classifier at the washing plant and overflow from the two finishing classifiers all join and are divided among four 25x9-ft. Dorr thickeners. After thickening to a specific gravity of 1.400 the pulp is pumped by four 4-in. Dorrco diaphragm pumps to the first of a series of five 25x20-ft. Dorr agitators. After passing through all five agitators the pulp is then discharged into a 34x12-ft. Dorr thickener with a large volume of barren solution, and then into another thickener of the same size with a second barren wash. From the last thickener the pulp is drawn as required into two Moore filters, where the proper barren solution and water washes are given before the pulp is discarded to waste.

Rich solutions are clarified through sand clarifiers and precipitated by the Crowe-Merrill vacuum system. Two Merrill triangular precipitating presses are used. Lead acetate in small quantities is used to facilitate precipitation. Press heads assay from $2.50 to $4.50 (gold at $20.67) per ton of solution, depending upon the grade of ore being treated. Press tailings average around $0.02 per ton. Tailings are tested at regular intervals by the purple of cassius method to determine the zinc dust necessary.

Presses are cleaned when necessary and precipitates stored until melting. There is no special time for melting, generally about three melts being made a month. A final cut-off is made on the first of each month. Bullion molds are of cast iron, and the bars weigh about 45 lb. each. As the ore is free from base metals, a high-grade precipitate is obtained which requires no preliminary treatment before melting, and a bullion assaying around 940 fine is obtained. Each bar of bullion is drilled in at least four places and a composite sample assayed. Bullion is sent by first-class mail directly to the mint.

Fluxes used in melting are made up in large quantities and in the following proportions: Silica, 31 per cent; soda ash, 21; borax, 30; manganese oxide, 8; and hematite, 10. For every 100 parts of dry precipitate 60 parts of the flux is used.

Power

Total power consumed for all purposes, including mining, milling, domestic lighting, and other uses, amounts to 33.16 kw.-hr. per ton of ore. Of this, 16.36 kw.-hr. per ton is used for milling.

Power is furnished from the company's power plant, consisting of two Polar Atlas diesel units run in synchronism with the Baguio power plant. The diesel engines generate 350 kva. at 440 volts, 3 phase, 60 cycles. Baguio's power plant is connected through a 17,000-volt line to the mine transformers which have a capacity of 600 kva. The combined system gives a plant capacity of 950 kva.

Three high-pressure compressors with a total capacity of 2,200 ft. of air at 100-lb. pressure supply the mine for rock drills and underground air hoists. A 500-cu.ft. 20-lb. low-pressure compressor supplies air for the mill circuit. Power is delivered to the various departments through an Asea switchboard, with individual metering of all circuits and the latest type of equipment for voltage regulation and control.

Recoveries and Costs

A considerable gain in extraction has been made by the all-sliming plant over that of the former sand and sliming plant, as shown in Table III.

The use of the two electrically and hydraulically operated Moore filters constitutes a variation from practice elsewhere in the district, Oliver filters being usual. Results obtained by daily samples show that 9.4 per cent of the recovery takes place in the filters. The figures given here compare favorably with other types of filters used in the district: Feed to Moore filters, $1.26. Filter tailings washed, $0.57.

Costs at Itogon are much lower than at the average plant of the same size, particularly so when the problems of transportation, labor, and plant isolation are considered. Most of the supplies come from the United States, and there is a considerable charge for freight and handling. In many shipments the cost of transportation from Manila to the mine is much more than the freight from the States to Manila. Cyanide is bought in Canada, and zinc dust, balls, and many other items are bought in Europe, and pay a relatively high duty.

A general survey of per ton costs is given in Table IV.

Table V gives a segregation of direct operating costs for the various departments in the mill.

The solutions are maintained at a cyanide strength of 1.25 lb. of free cyanide per ton of solution and the lime is held around 0.80 lb. per ton of solution.

In Table VII the assays of products during the passing of the pulp through the plant (gold being figured at $20.67) are given.

Itogon's operating staff consists of seventeen Americans or Europeans, who with their families are quartered in seven staff residences and four housekeeping apartments, with a mess and club building which has accommodations for nine single men. One thousand natives are employed in mine, mill, and plant operations, of which approximately 70 per cent are Filipinos and 30 per cent Igorots. The company *barrios*, or

native villages, entirely under the jurisdiction of the company, house some 3,000 people. Two stores are operated for their convenience, and handle a complete line of foods and drygoods. Free schools are maintained by the company, and a movie theater is operated at cost for the entertainment of the laborers.

The operating organization is made up of ten departments: Administrative, Mining, Mill, Accounting and *Bodega* (Store), Engineering, Assaying, Power and Electrical, Mechanical, Construction and Outside, Hospital and Sanitation. A superintendent is in charge of each department, and shift bosses are responsible for divisions in the mine and mill operations on a 24-hour schedule.

A budget system of expenditure for all departments has been most effective in keeping operating costs down. At the beginning of each year a definite program for each department is drawn up. From the previous year's experience a definite appropriation is agreed upon in consultation with the superintendent of each department. The executive department naturally holds this allowance to the lowest possible figure commensurate with efficient operation. No capital expenditure is undertaken at any time without the approval of the general managers.

The system of mine accounting is such that a set-up of actual expenditures showing the figures both of today and up to date in each account in comparison with budget allowances is posted daily in each department and has been helpful to department superintendents in directing their work and in holding their costs to a minimum.

A full summary of operating figures is made up daily for the general superintendent and shows plainly the trend of expenditures, production, labor employed, and operating efficiency.

Careful watch is kept over the health of the laborers and their families. Each man is examined before he is granted a *chapa,* or number, for identification purposes, and hospital and medical service is provided free of charge by the company. The hospital, which is completely modern, is in charge of a resident physician and a graduate trained nurse. A sanitary inspector watches over the cleanliness of the various *barrios,* and sees that every possible precaution is taken to prevent the outbreak of disease.

The staff of Itogon is headed by Ralph R. Allison, general superintendent, with the following men: Roscoe H. Canon, mine superintendent; Clyde R. Smith, mill superintendent; D. W. Blythe, A. M. Dixon, Henry Schick, and C. A. Davis, mine shift bosses; H. Iverson, W. W. Fenton, and Joe Scotty, mill shift bosses; R. Ewing, mine engineer; E. J. Sanders, mine accountant; A. Schoenert, electrical and power superintendent; J. C. Anderson, assayer and mess manager; E. Wagor, construction superintendent; E. Velarde, mechanical superintendent; Dr. P. Biason, resident physician; and Mrs. P. Biason, the head nurse.

J. B. Stapler, former general superintendent at Itogon, and now consulting engineer on the staff of Marsman & Company, acts as advisory engineer.

C. A. Weekley, formerly mill superintendent of Itogon, is now general mill superintendent for all of the plants under Marsman management, and acts also in an advisory capacity for the company.

Messrs. Stapler and Weekley, of Marsman & Company, and Messrs. Allison and Canon, of the Itogon Mining Company, have kindly supplied the information from which this article has been prepared.

An Aërial Photographic Survey of the Blow-Me-Down Area In Newfoundland

Geology found analogous to the Bushveld Complex of South Africa is the first on the island to be studied from the air

A. K. Snelgrove

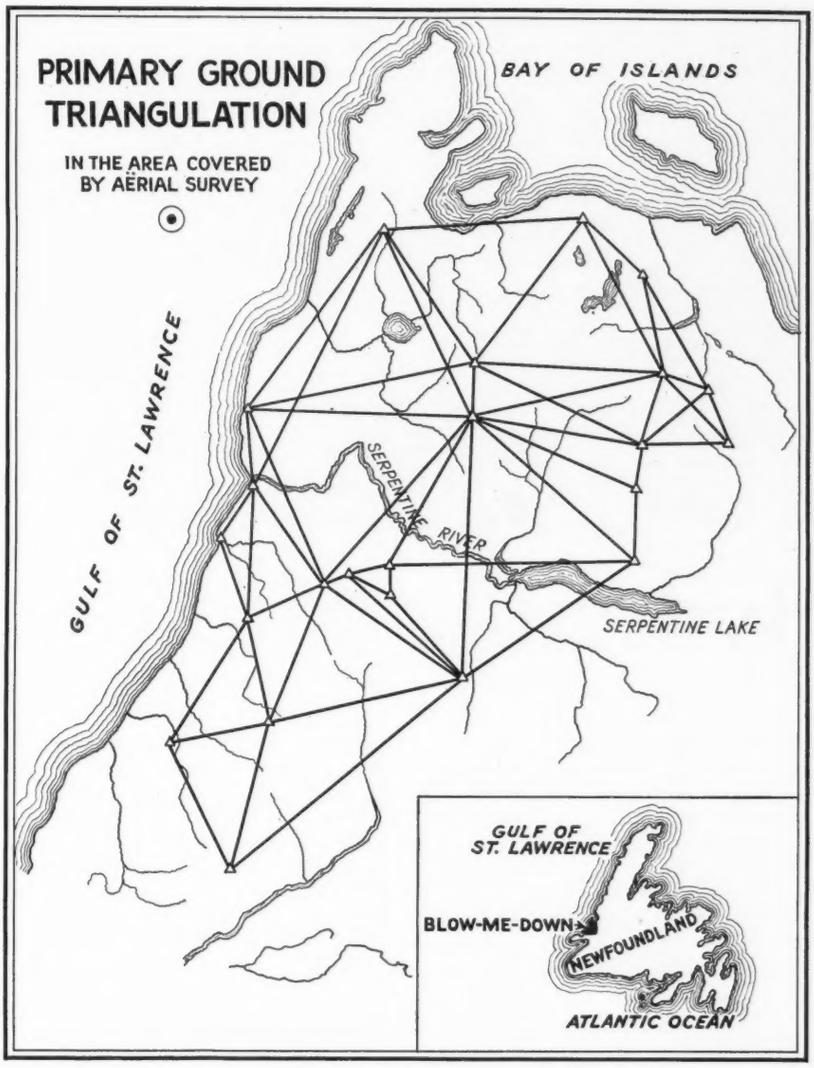
Assistant Professor of Geology at Princeton University and Newfoundland Government Geologist

THE dominant maritime influence in Newfoundland's history is strikingly shown in its survey development. From the crude sketches of early navigators an excellent series of charts of the intricate shore line of the island has been evolved, made by French and British admiralty surveyors, including the famous circumnavigator Captain Cook, who was at one time "Marine Surveyor" of Newfoundland.

The interior of the island, however, awaited even approximate delineation of most of its major features until the pioneer geological surveyor, Alexander Murray, beginning in 1864, and his successor, James P. Howley, ascended the main rivers and triangulated adjacent mountain tops. Later, railway surveys across the island added materially to existing data and served as points of origin for interior land grants, notably to the Reid railway builders and English and American paper companies. Reconnaissance mapping by these companies in comparatively recent years has added much to the cartography of the interior. In general, however, few detailed maps of the hinterland are available, and the most up-to-date map of the island, published by the International Paper & Power Company, reveals large areas of which little is known. Fortunately, a geodetic survey of the island was begun in 1935, with the cooperation of the Geodetic Survey of Canada, and the survey here described forms one of a series of detailed topographic sheets, controlled by the geodetic triangulation, to be issued at a scale of one inch to a mile by the Newfoundland Department of Natural Resources.

The Blow-Me-Down survey, made in 1933, was the first application of aërial photography to geological work in the island of Newfoundland. It covers an area of 380 square miles. The Blow-Me-Down region is a barren plateau of serpentine rock, with an average elevation of 2,000 ft. above sea level. This plateau is surrounded and divided by a verdant lowland underlain by sedimentary and volcanic rocks. (See the halftone illustration which appears on the next page.)

Preliminary investigations in 1932 by a Princeton University geological expedition indicated that the Blow-Me-Down range was of extraordinary geological interest, in that it was composed of two saucer-shaped, gravity-stratified igneous masses, corresponding somewhat to the Bushveld Complex of South



SERPENTINE LAKE looking west along the flat valley which divides the North and South ranges of the Blow-Me-Down area

Africa. To provide a topographic base for this hitherto unmapped region, the parents of two of the Princeton students on the expedition, J. L. Kemmerer, Jr., and F. W. Roebling, III, made possible an aërial photographic survey.

The area was covered by east-west strips of vertical photographs, taken at an altitude of 13,000 ft. above sea level, by C. J. Hubbard, L. D. Parker, and F. Hartley, of Boston, from a Fairchild seaplane, using an Eastman aërial camera. The average fore-and-aft overlap was about 25 per cent. A dozen oblique photographs were taken along the periphery of the area from a height of one mile. Two days suitable for aërial photography occurred within two weeks in the latter part of June.

In 1934, the Newfoundland Government provided a triangulation net for ground control, and the accompanying topographic map was compiled by A. H. Curren, Chief Surveyor, Department of Natural Resources, by fitting the photographs together to form a mosaic, which in turn was adjusted to conform to the ground control. This map is the base for a geological sheet about to be issued by the Geological Section of the Department of Natural Resources, Newfoundland, comprising the results of two years' field study by Dr. J. H. Cooper.

The utility of such an aërial survey, from the geological point of view, lies primarily in the fact that each photograph provides a working base map on which geological features can be located readily in the field. The boundaries of the treeless serpentine rocks are easily recognized on the photographs. Individual rock types in the serpentinized, intrusive masses are less apparent from the air. In an area where roads are absent, the photographs reveal trappers' trails and other time-saving routes of travel. In the absence of a contoured map, the aërial photographs illustrate effectively the major physiographic features such as peneplains, cirques, hanging valleys, and the like. From the topographer's point of view, the drainage features are more accurately and quickly plotted from the photographs than would be possible from the ground.

This survey demonstrated the applicability of aërial photography to geological work under local conditions. From experience gained, it appears that more fore-and-aft overlap to enable plotting by the radial line method, or complete oblique coverage following the methods developed by O. M. Miller, of the American Geographical Society, would be preferable to employing the large amount of ground work entailed by the present survey. Though the copper, chrome, and asbestos deposits of the Blow-Me-Down area have been of little importance hitherto, the geological map based on this survey will be an incentive and aid in further prospecting.

Hydraulicking at the Indian Hill Mine, Sierra County, Calif.

Some Practical Points on Hydraulic Mining

The author records a study of nozzle flow and determines facts which contribute to a refinement in the technique of Hydraulic Placer Operations

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WHEN the Sawyer decision of 1884 terminated hydraulic mining in the district where the largest deposits suitable for this type of operation are situated, that method of gold recovery became almost a lost art. Practically all of the "old-timers" who participated in and developed this unique method of low-cost mining are either dead or inactive now, but, due to the increased interest in gold, and the prospective overcoming of the tailings problem by government construction of débris dams, hydraulic mining in California is enjoying a rebirth unequaled by any other industry in the State. However, this revival has been unaccompanied by any advances and scarcely any refinements in methods over those employed by our predecessors of the nineteenth century. Equipment remains practically unchanged and the art of piping itself has suffered by its somnipathy of the past fifty years. In spite of this lack of advancement, hydraulic mining is not an obsolete industry but is still the most economical and practical method of mining alluvial deposits where the topography and type of gravel permit. With few exceptions, our best authorities on the subject are those of the past century, the works of A. J. Bowie, Jr., still being considered standard by those engaged in hydraulic mining. One of the most notable of these exceptions is the very commendable work done by the United States Bureau of Mines.

Perhaps the most important item in successfully mining placer deposits by hydraulic methods is a thorough understanding of the work high-pressure water is capable of accomplishing, and then making it do its utmost. In an hydraulic mine the water does the work it would take dozens of men to do, and it is uneconomical and certainly very poor business practice to allow such a potentially valuable "employee" to be idle or to work inefficiently.

Various degrees of tightness or cementation of gravels are found in the ancient channels suitable for hydraulicking in California, varying from an almost loose condition to one of a hardness resembling concrete. The former condition presents no great problem, and the other extreme, fortunately, occurs less often, and when it does, powder must be resorted to. We are interested primarily in the average gravels which occur most frequently, and which, if approached properly, can be mined economically by hydraulic pressure.

The importance of a high head or pressure of water is a matter not to be minimized, but inasmuch as this is usually dependent upon topographic features of the mine location, and cannot be increased without great expense, it is essential to make the most of that available. We have seen mines with a head of more than four hundred feet at which the operators had difficulty in cutting and washing a comparatively loose gravel and others where a very tight gravel was successfully and economically cut and the banks caved with heads as low as one hundred feet. The human factor is evidently an important one.

Properly designed giants or monitors of the correct size for the water available are necessary. Even where the water supply is sufficient for the operation of only one giant at a time, two are essential for efficient operations. This plan of operation permits the cutting and caving of the bank in a second or adjacent pit while the pitmen are engaged in the first pit in disposing of boulders, breaking pipeclay, or in extending the bedrock cut up to the face of the bank. Otherwise the water would be running to waste while these necessary operations were being performed.

Another item which should be mentioned is the proper location of the giant. It should be placed at an obtuse angle to the bank to be cut and as close as possible without endangering the operator or equipment from the caving banks. Those interested in hydraulic mining should bear in mind the fact that very tightly cemented banks occasionally tip over as a unit instead of caving in and collapsing. In attacking high banks it is advisable to work the deposit off in two or more benches, minimizing the danger to the operator and permitting placing the giant closer to the bank.

Of equal importance with the giant is the nozzle itself. An improperly designed or inaccurately machined nozzle

will greatly lower the efficiency of the cutting stream and may make the difference between success and failure of the entire operation. The selection of the correct size nozzle for cutting a chosen stratum of gravel should be made with care. Inasmuch as the erosive power of water varies as the square of its velocity, this choice must be a compromise between the highest obtainable velocity and maximum volume of flow; the high velocity to loosen the gravel by virtue of its force in collision and the volume of flow to aid by dissolution of soluble substances of cementation and to provide an undercut sufficiently wide to prevent blocking by small boulders.

An argument in distinct favor of the smaller nozzle, with its accompanying higher velocity, is that its resultant stream will be more concentrated at its point of collision with the bank to be cut than that of the larger one, making a much more efficient cutting agent than a loosely associated widely spread stream, and greatly increasing the actual amount of work done for each unit of water per square inch cross-sectional area of the nozzle orifice. To illustrate further: At its exact moment of issuance from the nozzle, this stream is a liquid continuous projectile, cylindrical in shape, of the exact diameter of the nozzle, and an ideal cutting tool for disintegrating gravel. Unfortunately, however, the moment the water is released from confinement, it is acted upon by several outside influences. The most noticeable of these are gravity and atmospheric conditions; that is, wind, air currents and air resistance as well as unequal distortion of the individual water particles themselves due to their velocity. The effect of these influences is to spoil the shape of our perfectly cylindrical liquid projectile, causing it, as it leaves the nozzle, first to flatten out on its edges into a horizontal oval shape, and then, since the outer portion of a cylindrical jet of water has a much lower velocity than the center area, the under side of the stream loses contact with the high velocity core and falls toward the earth sooner. This causes the colliding face of the stream to resemble an inverted pear, much changed in shape, and, of more importance, with a cross-sectional area several times that of the nozzle, increasing in direct relationship to the distance between the nozzle and the bank. A number of other factors have a more or less pertinent effect upon the size of this area; namely, the angle the nozzle makes with the horizontal, the length of the nozzle itself, the tendency of the stream to rotate, gravity, and atmospheric conditions. For this reason it is impossible to predict accurately the cutting-face area of any particular giant set-up, but in practice it is readily observed that the cutting-face area of the larger nozzle, with its lower velocity, increases to such an extent that in spite of the increased volume of flow there is less water and at a lower velocity to work against each square inch of gravel bank that is being disintegrated.

The fact that the smaller nozzle, head of water, and other conditions remaining the same has a much higher velocity than a larger one is so evident from observation that it should require no proof. However, the formulas most in use at the present time do not bear this out. Gardiner and Johnson in the Bureau of Mines Information Circular No. 6787 give the formula for calculating the volume of flow through nozzles as: $Q = 8\,C\,A\,\sqrt{h}$

Where Q = cubic feet per second
A = area of nozzle in square feet
h = effective head (in feet) at nozzle
C = coefficient of discharge usually taken as 0.9

and a similar one in use and giving practically the same results:

$$Q = \frac{.7854\,d^2}{2}\sqrt{\frac{n}{10}}$$

Where d is diameter of nozzle in inches.

Though the formulas just presented may serve their purpose in giving a rough estimate of volume of flow through nozzles providing the effective head at the nozzle is known—a factor considerably less than the static head, especially for the long pipe lines usually encountered in hydraulic mine pits—they fall short when we endeavor to find the velocity of flow from them by the obvious $V = \frac{Q}{A}$

Where V = velocity in feet per second
and A = nozzle area in square feet, inasmuch as this will show almost identical velocities for all sizes of nozzles, the head remaining the same.

To obtain a more accurate picture of what actually occurs, it is first necessary to compute the *pipe* velocity. Merriman's "Treatise on Hydraulics" gives the following, which works out quite accurately in practice and checks closely with experiments which I conducted under actual operating conditions:

Pipe velocity $v =$

$$\sqrt{\frac{2gh}{m + f(L/d) + (1/Cv)^2(d/D)^4}}$$

Where m = coefficient for loss of head due to entrance at penstock (0. for perfect mouthpiece — 0.5 for standard tube)
f = coefficient of friction in pipe line—usually 0.02
L = length of pipe line in feet
d = diameter of pipe line in feet
D = diameter of nozzle in feet
Cv = coefficient of velocity for nozzle—usually 0.97
g = acceleration due to gravity (32.16)
h = total head at nozzle

Then
Nozzle velocity $V = (d/D)^2\,v$

and
Discharge $Q = .7854D^2\,V$

An experienced and efficient pipe man is a prerequisite for the successful operation of any hydraulic mine. He can contribute more toward a smooth and continuous production than all the rest of the employees combined. As there is no substitute way for a financially successful season in an hydraulic mine other than running the maximum quantity of pay gravel through the sluices day after day as long as there is available water, and, of course, as economically as possible, it is the pipe man's responsibility to make the water do its full duty. The mine is receiving no income while the water is running clear in the sluices. After the first cave has been made in the bank, it is often possible for a judicious pipe man to cut for his second cave in such a manner that the water used for this purpose is also washing the already disintegrated gravel through the sluices, thus making the water do double work.

Where banks are to be worked off in benches, and the gravel is tightly ce-

Auriferous gravel bank of the Indian Hill mine. An eight-inch water line supplies water for hydraulicking

mented, it is usually possible for the pipe man to select by trial a horizontal stratum in the face to cut, less hard than those strata directly above or below it. Where the bottom gravel is covered by a layer of pipeclay, it is often found that the stratum directly above the pipeclay cuts with comparative ease even when the rest of the gravel is tightly cemented. This is a condition frequently encountered in the Tertiary channels in California. In cutting very tightly cemented gravels the operator should avoid "punching holes" in the bank with the jet, as it soon loses its cutting power on one spot. The reason for this is that a permanent wedge of water is quickly built up at the contact face in the hole and the stream is simply deflected and no advantage gained by the impact. This can be avoided by a slight horizontal movement of the deflecting nozzle, sufficient to change the angle of incidence of the stream, making the cut a continuous slot. As the bank is about to cave, the water should be turned away to another part of the pit. If this is not done, and the cave is of any great size, the gravel will follow the water, endangering the operator, and occasionally burying the giant and causing the sluices to overflow by this sudden rush of material.

The pipe man usually has sufficient warning, as small loose pebbles drop from the top portion of the bank a moment or so before the entire bank collapses. Because of the difficulty of providing adequate lighting, the night pipe man has not this advantage, and when the bank is high and the giant is in a hazardous position it is often advisable to have the night operator cut for a cave, but leave one or two "pillars" standing, sufficient to support the bank. The day shift then quickly cuts out the pillars, bringing down the cave safely.

A great deal of information is available on sluice designing and construction, a little of it practical but most of it otherwise. The reason for this is that rarely, if ever, do any two hydraulic mines present identical problems or conditions. The design of the perfect sluice is dependent upon the dump room available, bedrock grade, size and percentage of boulders, tightness or cementation of the gravel, type of gold, and the amount of water available. It is seldom that the best sluice system is obtained at a mine without the trial of a season's run. In the construction work it is well to have this in mind, as it is often found essential, after a trial run, either to increase or decrease the grade, change the amount of banking on curves, or to correct the design in some other way. In a newly opened mine, if the sluices are constructed with the idea of absolute permanence at first, any necessary changes may be found to be of great expense.

When working on cemented gravel it is advantageous to have as many drops as possible in the system, so that the gravel as it leaves the first box is caused to fall from a height of at least a few feet before entering the second box, and so on throughout the length of the entire system if the topography permits. The force of the fall and the churning action of the water help to disintegrate the gravel and release the gold held in it, so that it can be caught by the riffles. For this reason several comparatively short boxes with a drop between each are more to be desired than one long sluice, even if greater in length than that of the combined short boxes. The churning action of the water at the drops also serves to mix the gravel and water more thoroughly, increasing the carrying capacity of the water and preventing the gravel from packing in the sluices. A grade of from 5 to 6 in. to the box 12 ft. long is usually found to be satisfactory. However, a steeper grade than this is necessary where the water supply is limited, sacrificing gold recovery somewhat for capacity. This situation can be remedied by lengthening the sluice system and installing undercurrents. There are no set figures for length of sluices, but where conditions permit it is good practice to continue adding boxes as long as the additional gold recovery exceeds the cost of installation.

Block riffles, cut from timber on the ground, probably combine economy with efficiency better than any other type. These are easily installed and removed for clean-ups, and the cost of replacement when worn out is low. Heavy iron rails are excellent for this purpose when available, especially for cemented gravels, but the cost of transportation, if not the initial cost, usually makes their use for an extensive sluice prohibitive.

A well-designed and well-equipped hydraulic mine contains no "bottle necks." For instance, the sluice system should be of adequate capacity to handle without delay all the gravel the giants and available water are capable of disintegrating and washing to it. Equipment and methods of handling boulders should be such that piping operations are continuous and not delayed while the pit is being cleared.

The efficiency of an hydraulic mine is usually inversely proportional to the amount of labor required. Except in unusual circumstances, five to seven men per shift are the maximum amount of labor required in the average pit. Where more help than this is necessary it is usually an indication that manual labor is being expensively substituted for work that should be performed hydraulically. There is no real reason why any hydraulic mining project, even with comparatively low-grade gravel, should not be an economical success, provided the necessary prerequisites are available; namely, competent supervision, adequate water supply, sufficient dump, and cheap storage or disposal of tailings. The lack of any one of these is more than likely to spell failure from the outset.

Solving the Strike and Pitch

Speed and accuracy are promoted by a mathematical solution used on geologic problems dealing with formation intersections

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GEOLOGISTS and MINING ENGINEERS have the common problem of finding the strike and pitch of the intersection of two formations, which can be solved graphically, either by descriptive geometry or structure contours. The mathematical formula described herewith is based on a common one that the tangent of the dip in any desired direction in a plane, equals the tangent of the true dip times the cosine of the angle between the directions of the true dip and the desired dip. The line of intersection being common to both planes, allows this information to be set up in the form of an equation, and a formula developed that gives result simply and directly.

# of Intersecting Formations by a Formula

INTERSECTION OF TWO PLANES FORMULA

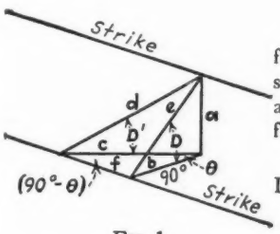


FIG. 1

The following formula (2) is developed for solving problems involving the intersection of two planes, and has a practical application when the planes are geological formations given by their strikes and dips.

In Fig. 1 $\tan D = \frac{a}{b}$ and $\tan D' = \frac{a}{c}$

$\cos \theta = \sin (90° - \theta) = \frac{b}{c}$ and

$b \tan D = c \tan D'$ or $\frac{b}{c} \tan D = \tan D'$

or $\tan D' = \tan D \cos \theta$, or $\tan D \sin (90° - \theta)$ (1)

The foregoing formula, described in the leading paragraph, is in common usage and is hereafter applied to two intersecting planes. The line of intersection is common to both planes and has the same attitude in each, so the following equation is set up. Here, however, for simplicity, the $(90° - \theta)$ of Fig. 1 corresponds to θ of Fig. 2, which is the angle sought in the solution.

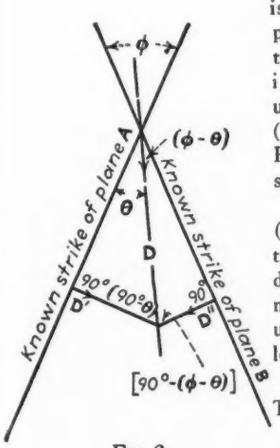


FIG. 2

From Fig. 2, $\tan D' \sin \theta = \tan D'' \sin (\phi - \theta)$ as each equals $\tan D$, the pitch of the intersection. For use as a general case, dips are used as shown in Fig. 3, which makes dips greater than 90° negative, or use dips to the right as positive and to the left as negative.

Then $\frac{\tan D'}{\tan D''} = \frac{\sin \phi \cos \theta - \sin \theta \cos \phi}{\sin \theta}$

from expanding the $\sin$ of $(\phi - \theta)$

or, $-\tan D' \cot D'' = \sin \phi \cot \theta - \cos \phi$

or, $\sin \phi \cot \theta = \cos \phi - \tan D' \cot D''$

Then $\tan \theta = \frac{\sin \phi}{\cos \phi - \tan D' \cot D''}$ (2)

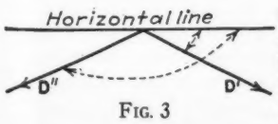
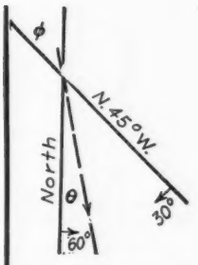


FIG. 3

The signs will show where the intersection lies from the known strike of plane A, and the pitch can be readily obtained from Formula 1, using $\tan D = \tan D' \sin \theta$ of Fig. 2. In this case use regular values for D' or D'', disregard signs, and determine if the pitch is up or down by inspection.

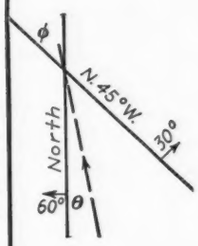
EXAMPLES



(1) Plane A, strike due north, dip 60° east
Plane B, strike N. 45° W. dip 30° west
Then $\phi = 45°$, $D' = 60°$, and $D'' = 150°$

$Tan\ \theta = \frac{sin\ 45°}{cos\ 45° - (tan\ 60°\ cot\ 150°)} = \frac{0.707}{0.707 - (1.732 \times -1.732)} = \theta.191$

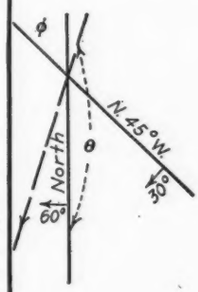
Then $\theta = 10°49'$ and $tan\ D = tan\ 60°\ sin\ 10°49' = 0.326$
$D = 18°03'$ south by inspection.
Then the attitude of the intersection is, Strike N. 10°49′ W., pitch 18°03′ south.



(2) Plane A, strike due north, dip 60° west
Plane B, strike N. 45° W. Dip 30° east
Then $\phi = 45°$, $D' = 120°$, and $D'' = 30°$

$Tan\ \theta = \frac{sin\ 45°}{cos\ 45° - (tan\ 120°\ cot\ 30°)} = \frac{0.707}{0.707 - (-1.732 \times 1.732)} = 0.191$

Then $\theta = 10°49'$ and $tan\ D = tan\ 60°\ sin\ 10°49' = 0.326$ $D = 18°03'$ north by inspection. Then the attitude of the intersection is Strike N. 10°49′ W., pitch 18°03′ north.



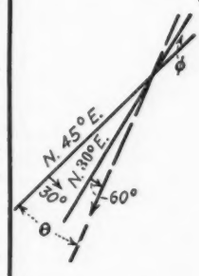
(3) Plane A, strike due north, dip 60° west
Plane B, strike N. 45° W., dip 30° west
Then $\phi = 45°$, $D' = 120°$, and $D'' = 150°$

$Tan\ \theta = \frac{sin\ 45°}{cos\ 45° - (tan\ 120°\ cot\ 150°)} = \frac{0.707}{0.707 - (-1.732 \times -1.732)} = -0.380$

Then $\theta = 162°53'$, which makes the strike N. 17°07′ E.

$Tan\ D = tan\ 60°\ sin\ 162°53'$, or $17°07' = 0.509$, $D = 26°59'$.

The pitch by inspection is south 26°59′.



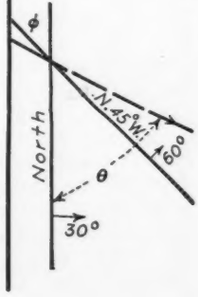
(4) Plane A, strike N. 45° E., dip 30° east
Plane B, strike N. 30° E., dip 60° east
Then $\phi = 15°$, $D' = 30°$, $D'' = 60°$.

$Tan\ \theta = \frac{sin\ 15°}{cos\ 15° - (tan\ 30°\ cot\ 60°)} = \frac{0.259}{0.966 - (0.577 \times 0.577)} = 0.409$

$\theta = 22°15'$ and strike of the intersection is N. 22°45′E

$Tan\ D = tan\ 30°\ sin\ 22°15' = 0.219$ $D = 12°21'$

The pitch is 12°21′ south.



Plane A, strike due north, dip 30° east
Plane B, strike N. 45° W., dip 60° east
Then $\phi = 45°$, $D' = 30°$, and $D'' = 60°$.

$Tan\ \theta = \frac{sin\ 45°}{cos\ 45° - (tan\ 30° \times cot\ 60°)} = \frac{0.707}{0.707 - (0.577 \times 0.577)} = 1.890$

Then $\theta = 62°07'$ and the strike of the intersection is N. 62°07′ W.

$Tan\ D = tan\ 30°\ sin\ 62°07' = 0.510$, $D = 27°01'$.

The pitch is south 27°01′.

Budgetary Control

For Gold-Mining Companies

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GRADUAL DEPLETION of the world's richer ore reserves, and the constant rise of material and labor costs, are making it increasingly necessary for gold-mining companies to search for means of controlling recoveries and expenditures in order to obtain for their stockholders an adequate return on capital. Accordingly, the more progressive mining engineers and accountants are examining the experiences of industrial and governmental institutions in an effort to discover managerial aids applicable to mining operations.

One of the most effective tools of management thus far developed is the modern budget. It has proved itself, wherever properly applied, of tremendous value in restricting costs close to the irreducible minimum, in planning finances and capital extensions, and in winning the maximum profit possible from a given orebody. Mining companies, on the whole, have been rather slow to apply budgeting to their operations entirely, although most mines do use a crude and an incomplete kind of budgetary system. Mining literature is barren of any discussion of the subject, and, it may well be, herein lies one of the most serious obstacles to its widespread application in the past. This article is presented as an initial contribution which may engender future discussions, as well as render a short outline for mining executives who may be interested.

Budgetary control may be defined as a managerial device, founded upon good mineral economics, scientific management, and progressive accounting technique, whereby definite objectives of performance for profits, recoveries, and costs are established, and, by means of careful checking with actual results, costs are controlled, the utmost of profit is obtained from the orebody, and the formulation of executive policies is facilitated. By the employment of such a system blueprints of management, as it were, are prepared at the commencement of operations in much the same way that the architect draws plans of a building or the engineer plans for mine workings.

In former years budgets were prepared under the doubtful formula of "income minus costs equals profit." Results were acceptable, when compared with those obtaining where no budget was employed, but did not meet the needs of forward-looking executives, who, realizing that profit was the end of all mining activity, demanded that the formula be rearranged to "income minus profit equals costs." Thus, profit is now provided for first, and the amounts of required recovery and allowable costs are adjusted to the extent permitted by applicable mineral economics until an acceptable balance is obtained. The following formula will prove helpful in the preparation of the budget:

$$P\left(\frac{D \times T}{20}\right) CF + Inc = FMP + TMG + T\,MI + G$$

where

P	= price of gold
D	= grade in pennyweights
CF	= correction factor — to bring grade to an "as-sold" basis
Inc	= miscellaneous income
FMP	= fair minimum profit
T	= tons
MG	= per-ton cost of mining
MI	= per-ton cost of milling
G	= general expenses

By the use of this formula the amounts to be budgeted for can be quickly brought into agreement with one another, and the effect of each upon the others readily observed. As each section of the budget is presented by a department head, it should be fitted into the formula and accepted, rejected, or revised only after its relation to the whole budget is noted. Of course, the general manager or consulting engineer should check the estimate with past results, the existing situation, and his general experience.

Though the price of gold is fixed at $35 an ounce for gold which is sold in the United States, many foreign companies sell their bullion in London, with the result that they have a widely varying price for their product. In such circumstances it becomes necessary to estimate the price of gold for the budget period; a hopeless task in the present state of international economics.

Mines which operate in South American countries and which also sell their bullion in London are confronted with a most difficult task in the preparation of their budgets. Inasmuch as the rate of exchange upon every South American country at present fluctuates widely and far from parity, there is a sharp variation in costs wholly unrelated to efficiency of operations. This is in addition to the fluctuating price of gold in London. Accordingly, every company operating under such conditions during the past few years has been faced with obstacles to budgeting which are seemingly unsurmountable.

But the budget, rather than being of no value when confronted with unusual circumstances, proves itself indispensable to companies operating under conditions whereby profit may be vitiated by non-operating factors. In the instance of companies operating under the conditions assumed in the foregoing it is possible, by a careful analysis of the effect of fluctuations in the rate of exchange upon costs and of variations in the London price of gold upon income, to prepare a budget so as to guide the company through the consequent uncertainties. The budget should first be prepared upon the assumptions that 85s. will be received for gold and that parity of exchange will rule. Tables should then be compiled showing the varying incomes and costs at all likely prices of gold and rates of exchange, it being remembered that costs are affected by only those expenditures which take place in the South American country.

Though it is necessary, for purposes of finance, to estimate the price of gold

Form No. 1

THE A. B. C. MINING COMPANY, INC.

Analysis of the Causes of Variations of December, 1935
Results From Budget Estimates and Their Effect On Estimated Profit

CAUSE OF VARIATIONS	EFFECT OF VARIATION ON ESTIMATE PROFIT	
INCOME	DECREASE	INCREASE
Tonnage		
Increased tonnage from stopes	.....	$1,913.10
Decreased tonnage from development	$1,001.00	.....
Increased tonnage from sands and dumps	.....	1,155.00
Grade		
Increased grade of ore from stopes	.....	1,855.00
Decreased grade of ore from development	939.05	.....
Increased grade of ore from sands and dumps	.....	320.25
Ore from mill bins	.....	2,058.70
Sale of Silver	.....	62.06
Miscellaneous Income	.....	467.19
COSTS		
Costs of Mining Ore		
Increased cost of materials	2,838.52	.....
Increased cost of labor	3,261.60	.....
Increased cost of power	560.78	.....
Increase due to larger tonnage	323.40	.....
Costs of Ore From Sands and Dumps		
Increased cost of labor	42.70	.....
Increased cost of supplies	18.30	.....
Increase due to larger tonnage	132.00	.....
Surface Transport		
Increase due to higher costs per ton	102.40	.....
Increase due to larger tonnage	13.20	.....
Milling Costs		
Increased cost of labor	430.00	.....
Increased cost of materials	510.00	.....
Increased cost of power	21.90	.....
Increase due to larger tonnage	682.00	.....
General Expenses		
Increase in Bullion Realization Expenses	105.02	.....
Increase in Medical Expenses	140.01	.....
Decrease in Mine Administration Expenses	.....	510.60
Decrease in Head Office Expenses	.....	472.61
Miscellaneous decreases in expenses	.....	314.20
Development and Prospecting	543.21	.....
Decrease of Profit from Budget	.....	2,536.38
Totals	$11,665.09	$11,655.09

Form No. 2

THE A. B. C. MINING COMPANY, INC.

Comparison of December, 1935 Results With Budget Estimates

	Budget		1935 Results		Variations of Actual From Budget
	Amount	Per Ton Milled	September Amount	Per Ton Milled	Amounts
INCOME					
Sale of gold	$121,712.50	$12.17	$127,074.50	$12.29	+[a] $5,362.00
Sale of silver	325.79	03	387.85	.03	+ 62.06
Miscellaneous income	2,000.00	.20	2,467.19	.24	+[b] 467.19
Totals	$124,038.29	$12.40	$129,929.54	$12.56	+ $5,891.25
COSTS					
Costs of mining ore	$16,800.00	$1.68	$23,784.30	$2.30	+[c] $6,984.30
Sands and dumps, ore cost	600.00	0.06	793.00	0.08	+[d] 193.00
Surface transport	1,900.00	0.19	2,015.60	0.19	+[e] 115.60
Milling	20,000.00	2.00	21,643.90	2.09	+ 1,643.90
General expenses	15,000.00	1.50	13,947.62	1.35	— 1,052.38
Development and prospecting	20,000.00	2.00	20,543.21	1.99	+ 543.21
Totals	$74,300.00	$7.43	$82.727.63	$8.00	+ $3,427.63
OPERATING PROFIT	$49,738.29	$4.97	$47,201.91	$4.56	— $2,536.33
Ounces of gold	3,477.5	.....	3,630.7	.....	+ 153.20
Ounces of silver	420	.....	500	.....	+ 80
Tons milled	10,000	.....	10,341	.....	+ 341
Ore from stopes	8,000	.....	8,154	.....	+ 154
Ore from mill bins	.....	.....	165	.....	+ 165
Ore from development	1,500	.....	1,412	.....	— 88
Ore from sands and dumps	500	.....	610	.....	+ 110
Grade of ore milled (dwt.)	6.955	.....	7.02	.....	.....
Ore from stopes (dwt.)	7.10	.....	7.23	.....	.....
Ore from bins (dwt.)	.....	.....	7.13	.....	.....
Ore from development (dwt.)	6.50	.....	6.12	.....	.....
Ore from sands and dumps (dwt.)	6.00	.....	6.30	.....	.....

NOTES: [a] Shortages of gold noted in mill during past two months recovered in December. [b] Extra dividend paid. Subsidiary. [c] Cost of ore per ton from stopes: Estimated $2.10, actual $2.92. [d] Cost of ore per ton from sands: Estimated $1.20, actual $1.30. [e] Cost of transport per ton: Estimated $0.20, actual $0.21.

Budgeting for profit is one of the most effective tools of management in eliminating extravagance and waste, and justifying each item of cost. It provides a "blueprint for management" and insures the organization an occasional "house cleaning"

and the rate of exchange for the coming period, the general manager should only be held responsible, at the end of the period when actual results are compared with the budget, for budget estimates of income and costs at the actual price of gold and rate of exchange.

The rate of profit to be budgeted presents the usually difficult problem. The Gordian knot can be cut, however, by the generalization that the profit should be that which the investors originally expected, provided such expectations are both reasonable and capable of fulfillment. For, in theory at least, before a competent group purchases a gold mine it determines the rate of profit which the particular mine should yield in order that the investment may be worth while. However, it is usual for recoveries and costs to differ substantially from early estimates, with the result that the expected rate of profit becomes but a vague dream. Inasmuch as the volume of operations, grade of ore, and costs must give way to mineral economics, the most practical profit to budget for is one which the mine can earn at a reasonable state of efficiency with existing or economically extended mill equipment, giving due regard to such matters as development progress, finances, and ore policy.

Division of the Budget

To facilitate preparation and analysis the budget is divided into several sections. The division of the budget should follow closely the classifications of the cost and general accounts, so as to permit accurate compilation of the budget and ready comparison of estimated and actual results. The following outline of the budget is the one most frequently employed, and it will be found best adapted to the needs of most mines.

Flow-of-Ore Budget—This estimate is the backbone of the entire budget. It gives the sources, quantities, and grades of ore to be mined and milled during the period. Obviously, recovery and costs are dependent upon these estimates, with the result that error in

their preparation will affect every portion of the budget and may nullify its value. Again, the determination of the quantities, grades, and sources of ore to be mined is intimately associated with the formulation of development, ore, and financial policies.

Recovery Budget—Shows the estimated bullion recovery for each month of the budget period. The grade of ore shown by mine samples should be corrected for error, dilution, and other factors until it is brought to an "as-sold" basis.

Miscellaneous Income—All sources of sundry income are here included.

Mining Budget—Gives the estimated cost of obtaining ore from the mine. It is based upon estimated rates of wages and prices of materials for the period under consideration. The budget should be prepared in accordance with normal accounting procedure, even to the extent of allowing for inventories of ore in stopes at the beginning and the end of the period. Where the company operates several properties in close proximity to one another, a separate budget is prepared for each mine.

Milling Budget—The estimated costs of milling should be given by departments such as crushing, grinding, cyaniding, and related operations.

Development-Cost Budget—The development operations to be carried on during the period should be carefully outlined and the cost budget prepared accordingly. Many companies make this budget a fixed amount per ton of ore mined or milled. The better practice, however, is to determine upon an amount which should be spent during each month of the period, after careful investigation of the needs of the mine and the probable status of the cash account.

Power, Shops, Pumping, Assaying—These four items cover those costs which are redistributed over mining, development, and milling costs. A budget should be prepared for each of these redistributed costs and the probable distributions for the period should be made to the other budgets.

Capital Outlay—Study should be made of capital requirements and of funds available for their satisfaction, in order that this budget may be prepared adequately. Properly, this budget should be tentatively prepared for a period of about five years, and with only the first year in detail. For, it must be remembered, the very nature of capital outlay is such that no one period can be considered by itself.

General Expense Budget—This budget is composed of several sections, such as mine administration, head-office expenses, medical expenses, and bullion-realization expenses. Most mines give less study to general expenses than to any other group, when, as a matter of experience, general expenses lend themselves most readily to budgetary analysis.

Supply and Material Budget—The stores department should assemble all estimates of material and supply requirements for the period, check them against inventories on hand, and then inform the purchasing department of supplies and materials which should be purchased for the period.

Salary and Wage Budget—On the basis of estimated wage rates and salary contracts and labor requirements for the period, this budget should be prepared by the personnel department.

Financial Budgets—These consist of the following: (1) Estimated cash receipts and disbursements for each month of the period. (2) Estimated profit and loss statement for each month of the period. (3) Estimated balance sheet at the end of the period.

Form No. 3

THE A. B. C. MINING COMPANY, INC.

Mine Administration Budget
December, 1935

	Total		Controllable		Partly Controllable		Non-Controllable	
Expense	*Budget*	*Actual*	*Budget*	*Actual*	*Budget*	*Actual*	*Budget*	*Actual*
Salaries	$.....	$.....	$.....	$.....	$.....	$.....	$.....	$.....
Office expense	.....	.....	.....	.....	.....	.....	.....	.....
Traveling	.....	.....	.....	.....	.....	.....	.....	.....
Motor cars	.....	.....	.....	.....	.....	.....	.....	.....
Stables	.....	.....	.....	.....	.....	.....	.....	.....
Legal fees	.....	.....	.....	.....	.....	.....	.....	.....
Postage	.....	.....	.....	.....	.....	.....	.....	.....
Telephone	.....	.....	.....	.....	.....	.....	.....	.....
Telegrams	.....	.....	.....	.....	.....	.....	.....	.....
Insurance	.....	.....	.....	.....	.....	.....	.....	.....
Auditors, fees	.....	.....	.....	.....	.....	.....	.....	.....
Totals	.....	.....	.....	.....	.....	.....	.....	.....

Cost Must Be Justified

Perhaps the greatest advantage of budget making lies in the thought and analysis necessary in its preparation. It necessitates justification for each cost and expense, and, if conscientiously done, will enable the elimination of much extravagance and waste. In most mines costs and expenditures will go on year after year without study being made as to whether they are justified or are too high. Preparation of the budget is an excellent opportunity to have a periodic "house cleaning." Prior to the actual drawing up of the budget every man should be thinking about the costs under his control and the possibilities of reducing them. The assistance of all executives such as the shift bosses and mine captains should be enlisted in the compilation of budget costs. These men have an experience and familiarity with the mine workings which can be of considerable aid. Further, their cooperation and good will, which will be gained, is of inestimable advantage, because, unless the entire organization gets into the spirit of the budget, maximum benefits cannot be obtained.

Preparatory to the installation of the cost budgets, consideration must be given to the proper departmentalization of the organization. Lines of authority and responsibility should be made definite and clear cut, in order to avoid the shifting of blame should results not measure up to standard. The duties and the extent of responsibility of each executive and junior executive should be clearly defined and in writing. Periodic statements should then be prepared in such form as to indicate unmistakably the degree of accomplishment.

Budgetary control, it must be borne in mind, is much more than the mere estimation of recovery, income, and costs; it includes continuous checking of actual results with the budget, the discovery of causes of variation, and the correction of faulty methods and erroneous policies. The budget is neither automatic nor self-generating, but the system of control and check, which is a fundamental part of the budget, can be given these qualities if governed by proper executive direction.

A budget, no matter how carefully devised and superintended, cannot perform miracles. It will not bring ore or grade to a mine, reduce costs below the irreducible minimum, or take the place of good management and competent labor. But it will assist materially in the reduction of costs, the elimination of waste, the formulation of executive policies, and the acquisition of maximum profits from the mine. A managerial device which can perform all of these should not be lightly rejected.

Mining Practice

At Nkana

II

Scraping an important factor in development and stoping —Ore hauled by trolley and battery locomotives—Boreholes in hanging wall facilitate drainage — Power-distribution system adequate— Effective use of native labor

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SUBLEVEL STOPING, as employed at Nkana, in both the steeper and the flatter parts of the ore deposit, was described in Part I of this article in the December issue of *Engineering and Mining Journal,* with special attention to scraping, by which the larger part of the tonnage broken is gotten into the chutes. In this, the second and final installment, details of the scraping procedure and equipment are presented and other phases of underground operations are discussed.

The scraper hoist is put in the hanging-wall drift and usually about 40 ft. back from the cut-out crosscut and then moved back from time to time as the stope retreats. It is bolted down to a 9x9-in. timber bed, which is blocked to the back of the drift with 8-in. round timber set into hitches in the back. Scraper posts for each draw hole are installed in the hanging-wall scraper drift. These posts consist of two 9x9-in. timbers set together and hitched into the floor and back of the drift.

Two heavy-section 18x9-in. iron clamps are bolted on to the timber and the scraper blocks are shackled to the clamps. These blocks are made of special Hadfield's manganese steel and are 18 in. in diameter. They are held at the required angle in a horizontal position by being suspended with chains from eyebolts in the back of the drift.

Scraper hoists are either of the standard I-R or Sullivan double-drum type driven by 50-hp. electric motors. For the longer stopes 100-hp. I-R hoists are being used. Wire rope $\frac{3}{4}$ in. in diameter with a close lay is used on the 50-hp. hoists and $\frac{7}{8}$-in. rope on the 100-hp. units.

A 14-in. Sullivan snatch block is used at the head of the stope. After the stope has opened out to 25 ft., two blocks are used.

Scrapers used are of the hoe type, 60 in. wide, with side plates. The backs and cheek plates are made of manganese steel, with detachable manganese-steel lip plates, and weigh 2,400 lb. Scrapers 2,800 lb. in weight are being operated in conjunction with the 100-hp. hoists.

In scraping, large rocks in the stopes have to be mud-blasted to permit handling by the scraper. An air whistle is provided in each stope and is used as a safety warning when blasting is being carried out during the shift.

When the scraper turns upside down the tail rope is slackened and led under a special bracket bolted on to its side. The ropes are then tightened and the scoop is turned back into position. Previously the method used was to shackle the tail rope to the scoop with a piece of chain.

The two major troubles to be faced in stope scraping are rope breakage and the pulling out of the tail-block eyebolt. When the former happens, the broken ends are tied in a reef knot, and after taking the strain the ends are cut off as close as possible with a cold set. The ropes are not spliced. All blocks have sufficient clearance to allow the knots to pass through.

Pulling out of the tail-block eyebolt is avoided by putting in two or three eyebolts and connecting them with a short chain, the block being fixed to the chain. A standard 14-in. Eaton-type eyebolt of $2\frac{1}{4}$-in. diameter with two wedges is used.

In another method, used for securing blocks at the top of the stope, two holes $2\frac{1}{2}$ ft. long are drilled about 4 in. apart. A piece of $\frac{3}{4}$-in. wire rope is led round a thimble and secured with a Crosby clamp. The ends of the rope are doubled back and driven into the holes with a ragged wedge and grouted in with cement. These sling eyebolts are put in at 4-ft. intervals and a chain shackled to the thimbles is run along the top of the stope. The tail block can then be moved to any position desired.

In putting up the ropes after a blast, a hemp rope is thrown down from sublevel to sublevel in order to pull up the scraper ropes.

Output in a scraper stope varies from about 6,000 tons per month in the 35-ft. stopes to 10,000 tons in the bigger stopes. Scraping is carried out on two shifts in some stopes and on three shifts where large tonnages are being broken. One scraper man looks after the scraping of two stopes and the grizzlies below the stopes.

Scraping costs based on a six months' period are given in Table IV.

Table IV—Scraping Costs, Nkana Mine, Six Months' Period Per Ton Scraped

	Shillings	
European salary and wages	0.17	$0.04
Native labor	0.18	$0.02
Supplies, including explosives	0.22	$0.05
Workshops	0.03	$0.01
Underground mechanics and electricians	0.07	$0.02
Power, electric	0.03	$0.01
Total	0.60	$0.15
Tons scraped per European shift		218
Tons scraped per native shift		19.5

Grizzlies are 15x8½ ft. in size and are constructed entirely of steel. Each is bolted on to three bearers concreted into hitches. The center bearer is a 16x6-in. joist 15 ft. long and the two end bearers are 9x7-in. joists 13 ft. long. The grizzly has four main bars, which are made in two sections and joined on the center bearer. The bars are spaced for a 22-in. opening by means of dividing pieces on the center and end bearers. Grizzly bars are constructed of 9x7-in. joists with an inverted 9x3½-in. channel riveted to the top flange of the joist, with 9x1-in. flat wearing bars riveted on top of the channels. Joists, 9x7 in. in size, with angle brackets, are used for the center dividers and 9x3½-in. channels with angle brackets for the end dividers. Three 9x1-in. wearing bar flats are bolted over the end and center divisions to protect them from wear. The grizzly is bolted together with $\frac{3}{4}$-in. and $\frac{7}{8}$-in., hex bolts, and $\frac{3}{4}$-in. counter sunk bolts are used for the spacers. Grizzlies are easily assembled and can be transferred to new position when the draw holes are no longer used.

Stope chutes are built of steel. Base stanchions of 12x4-in. channel section

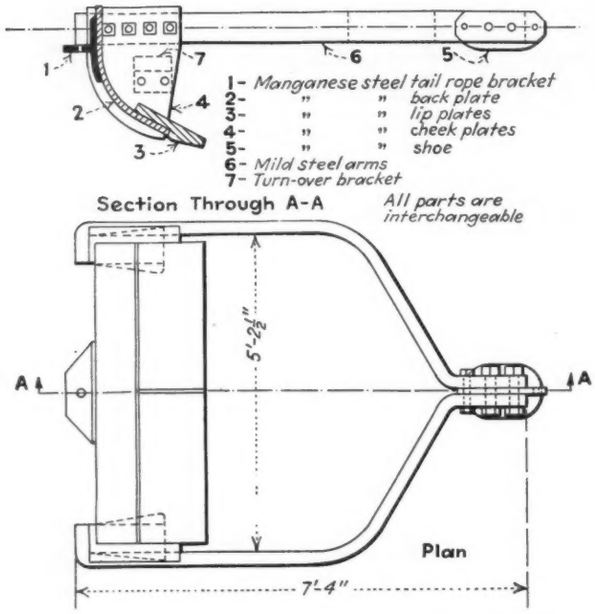


FIG. 6. . . . STOPE SCRAPER, 5-ft. size, used at Nkana mine, in plan and vertical section. Parts numbered 1 to 5 on the elevation are made of manganese steel. The arms (Part 6) are of mild steel, as is likewise the turnover bracket. All parts are interchangeable

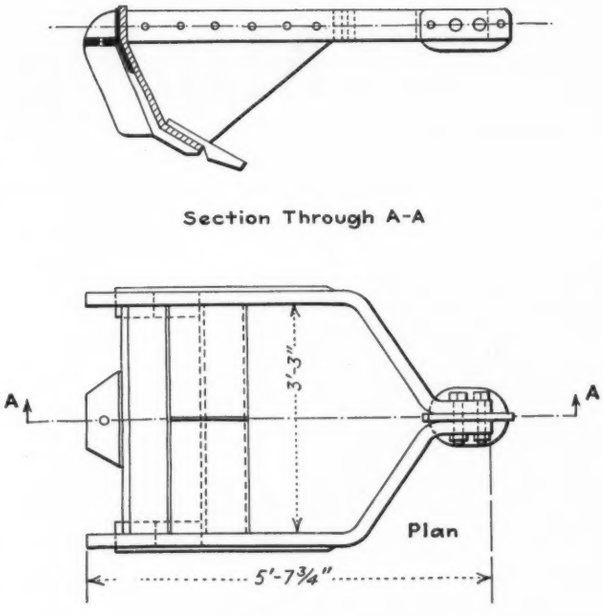


FIG. 7. . . . SCRAPER such as is used with a slide at Nkana. The parts are made of the same material as indicated in the sectional elevation in Fig 6

and 2 ft. long are concreted into the floor of the drift. The chute legs, which are 12x4-in. channels 17 ft. long, are spliced to the base stanchions. A 9x9-in. timber is bolted across the top of the chute legs and securely hitched into the back. Two 9x4½-in. timbers are bolted at the top and behind the legs and lined with ½-in. plates to form top filling of the opening.

The chute bottom is supported on two 7x3-in. channels, one in front of the chute legs and the other higher and behind. The bottom of the chute is made of six 10x3-in. channels bolted and covered with a ½-in. wearing plate. Main side plates made of ½-in. plate are bolted to the chute bottom and the chute legs. The chute door is 5 ft. wide, of the arc undercut type and reinforced with 6x3-in. channels, and operates on bearings bolted to the chute legs.

Another 9x9-in. timber is bolted behind the chute legs just below the bottom of the chute, and the space between the legs and sides of the excavation is closed in with 9x3-in. timber secured to the two 9x9's. All timber filling is backed with ½-in. steel plates bolted through the timber. An oxy-acetylene torch is used for cutting plates to size and shape required.

The air cylinder for operating the door is supported between two 9x3-in. channels bolted horizontally between the two chute legs, and is operated by a four-way valve.

The working platform consists of two 8x6-in. timber bearers, covered with 9x3-in. planks, hitched into the rock on one side and bolted to the chute legs on the other. A steel ladder affords access to the platform.

Originally, pole brackets and stop logs were used to stop spillage. This was not satisfactory and has been superseded by a hinged check door, which is free to lift and allow the large rocks through. In the new arrangement two auxiliary side plates are bolted to the chute legs and the main side plates, raising the heights of the sides. A steel cover plate is bolted across the auxiliary sides, closing in a part of the top of the chute. An arc-type check door reinforced with 4x3-in. channels is hinged from pivot pins on the auxiliary side plates and fits down on top of the air-operated main door. The top plate allows room to bar and blast any rocks which have jammed above the chute, and the check door may be lifted to allow the large rocks through. See Fig. 12.

Ore Transportation

Main haulageways are equipped with 45-lb. rails, of 3-ft. gage, which are laid on treated local hardwood sleepers. The latter are 6 ft. long by 6 in. x 9 in. wide and are spaced 27 in. center to center. Most turn-outs are of 150-ft. radius. Ditches are carried on one side of the haulage 6 in. away from the edge of the sleepers.

Trolley wire is suspended as follows: Holes 2¼ in. in diameter are drilled in the back of the haulageway and into each is driven a pipe split at one end and having a coupling at the other. A tapered wooden plug is put into the split end of the pipe and a stoper machine with a special hammer is used to drive the pipe home. A pipe cut to the right length is then screwed into the coupling and carries a bracket at the right height with an insulator in the center.

Boards 9x1 in. in dimension are set 9 in. apart and may be bolted to the sides of the brackets as a safety guard. The trolley line is carried directly over the rail on the side opposite the chute. Guarding is put up only where the trolley line is less than 10 ft. above the rail, where material and supplies are unloaded, and opposite all chutes. The line is earthed at 50-ft. intervals and the rails are bonded.

Standard 180-cu.ft. Granby cars, fitted with ¾-in. Alliance couplings, are hauled in trains of nine by 13-ton Jeffrey trolley locomotives.

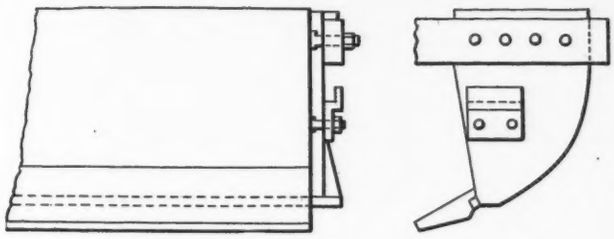
A fixed steel ramp is used for dumping the cars at the main grizzlies. These are built of 12x6-in. joists spaced 24 in. apart and fitted with renewable manganese-steel wearing pads made in short sections. A sketch of these pads is shown herewith. They are put on to the grizzly bar at the top and moved into position by sliding them down the bar.

Granby cars are cleaned at the main grizzly by means of a blowpipe using compressed air and water. We find it necessary to clean the cars once a shift.

Trains are loaded from steel chutes of the undercut arc type operated by an air cylinder and having a special check door. These have been described elsewhere in this article.

Waste is dumped into the waste pass system, the Granby cars being tipped by means of an air cylinder suspended from the back of the haulageway. A safety clamp is used to prevent the base of the car from tipping.

Tramming is carried out on three shifts, two white men being in charge on each level. All locomotives are driven by natives.



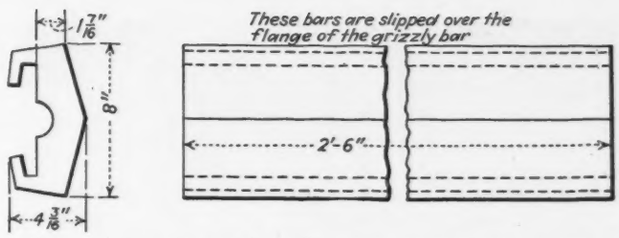
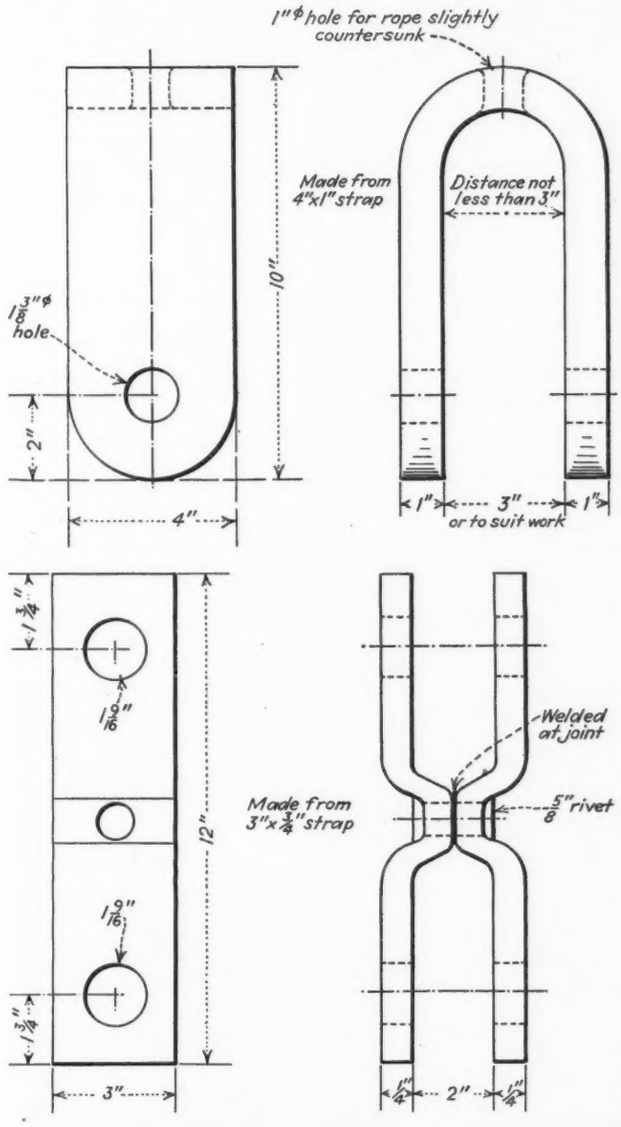


FIG. 11. . . . **WEARING BARS** of manganese steel for main grizzlies. They are slipped over the flange of the grizzly bar



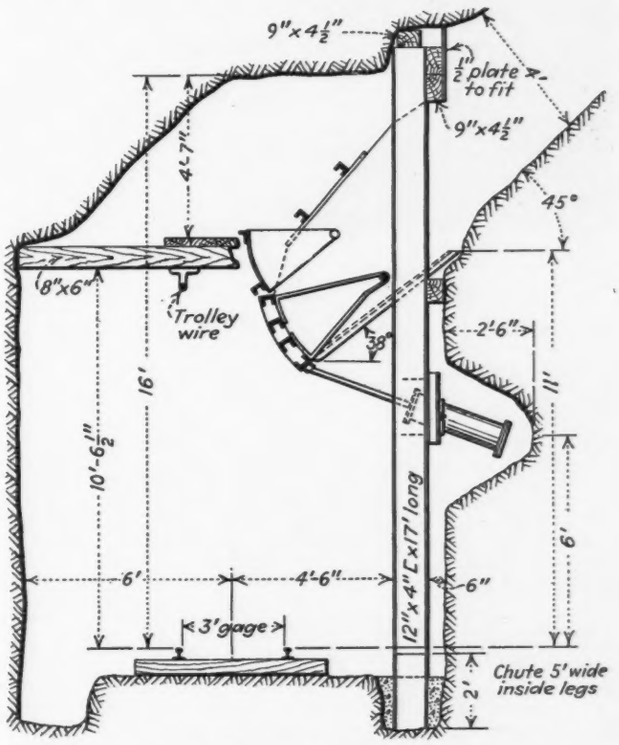


FIG. 12. . . . **STOPE CHUTE** built of steel and air-operated, in side elevation. The base stanchions of 12x4-in. channel and 2 ft. long are set in concrete in the drift floor, and to them are spliced the chute legs

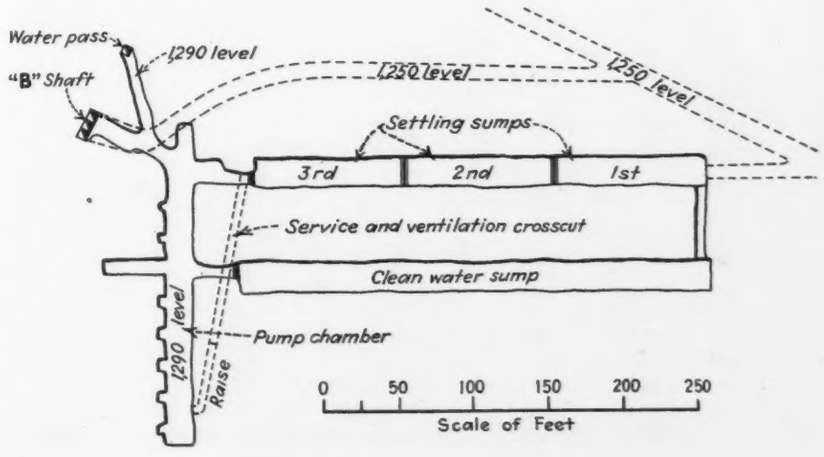
FIG. 13. . . . **PUMPING LAYOUT** designed for 1,290-ft. level of "B" shaft. Eight 1,500-g.p.m. centrifugal pumps and a 200-g.p.m. unit for handling sludge can be accommodated. The sumps will be arranged as shown.

STOPE SCRAPER DETAILS

Fig. 8 (top) shows the arrangement of the overturning bracket on the scraper.

Fig. 9 (center) illustrates the draw-rope shackle.

Fig. 10 (bottom), double-end Burns type shackle used for attaching blocks



SCRAPER STOPE, showing the benches

On the 600-ft. level, which is the main level of the mine at the moment, five trains handle 5,000 tons of muck per day. Table V presents tramming data that are based on a six months' period.

Table V—Tramming Data, Nkana Mine, Six Months' Period

Total tonnage trammed, 1,169,600

	Shillings	
Cost per ton trammed	0.21	($0.05)
Tons per European shift		512
Tons per native shift		24

Pumping—The hanging-wall beds of the orebody contain large quantities of water, which is systematically drained off by a series of diamond-drill holes drilled into the hanging at intervals along the 450-, 600-, and 900-ft. main haulage levels. Most of the water pumped at present is from the hanging wall at the north end of the orebody. Water has also been found in the foot-wall beds while driving the main crosscuts from Central shaft to the orebody, but this drains rapidly as the crosscuts on the levels below are advanced.

Drainage boreholes are drilled with a Sullivan Turbinair machine. They are started with an "NX" bit and cased before penetrating the first water-bearing beds, which are usually cut at about 20 ft. from the hanging wall. The 3-in. casing, with a control valve, is made tight by means of the layer of sacking and then secured by wire rope to eye-bolts cemented into the rock around the mouth of the hole. Drilling then proceeds with a "B" bit and core barrel using "E" rods. The second water-bearing beds are encountered at a depth of about 200 to 250 ft.

On the 900-ft. level at the extreme end of the orebody on the north side large quantities of water have been struck, one particular borehole showing a pressure of 265 lb. per square inch. The usual water pressure in the holes on this level is 165 lb. per square inch. Cost of this diamond drilling is 8s.6d. per foot.

Above the 600-ft. level the hanging-wall water has been practically drained away, but the draining continues on the 900-ft. level. The main pumping stations at present are on the 600- and 900-ft. levels. Quantity of water pumped is approximately 3,000,000 gal. per 24 hours. A 1,500-g.p.m. Harland pump at No. 4 incline takes the water from all the boreholes on the 900-ft. level north of this shaft. These boreholes are connected to two 6-in. pipes joined with Victaulic couplings which discharge into a sump at the pumping station. Pumps used are for the most part 1,000-g.p.m. Mather & Platt centrifugal units and 500 to 1,000-g.p.m. Pulsometers.

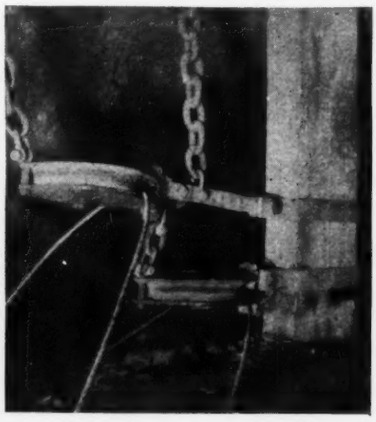
Table VI—Cost per Thousand Gallons Pumped

	Shillings	
Pumps and shaft column	0.31	$0.075
Underground drainage	0.01	$0.002
Diamond drilling	0.02	$0.005
	0.34	$0.082

Work is in progress for a new pumping arrangement. A pump chamber 200 ft. long and 18 ft. wide is to be provided on the 1,290-ft. level at "B" shaft. This will accommodate, if required, eight 1,500-g.p.m. centrifugal pumps and a 200-g.p.m. sludge plunger pump.

Two sumps, 300 ft. long and 20 ft. wide and approximately 40 ft. deep, are to run at right angles to the pump chamber, the floors of which are approximately on the same level as the latter. They will be cut to the floor elevation of the 1,250-ft. level, which will make the entire cubic volume of the

SCRAPER HOIST INSTALLED. This is a 50-hp. I-R unit with switch gear. It is put in the hanging-wall drift, usually about 40 ft. back from the cut-out crosscut and moved back from time to time as the stope retreats



SCRAPER POST with blocks, installed at bottom of stope. It consists of two 9x9-in. timbers set together and hitched into the floor and back. Two iron clamps are bolted to the post and scraper blocks are shackled to them

sumps available for holding water. One of these sumps will be the settling sump and will be divided into three separate sumps each 100 ft. long. Practically all water from the upper levels of the mine will be transferred to the 1,250-ft. level by means of raises driven in the orebody and the shaft pillar.

The water will enter the settling sumps on the 1,250-ft. level and will be distributed by a launder and quietening boxes. From these sumps the clear water will overflow into two launders, which will take it to a crosscut back of the sumps which leads to the clear-water sump. Both sump connections will be blocked off from the pump chamber by concrete walls. A sludge suction will be provided in the sumps, and the sludge will be handled by a Glenfield & Kennedy three-throw ram pump delivering through "B" shaft up a 4-in. column to surface.

A 30-in. ordinary suction orifice will be built into the wall of the clear water sump with a header, to which the centrifugal pumps will be attached. These pumps will also have a common 24-in. delivery pipe through which the water will be pumped up "B" shaft to surface. Access to the top of the settling sumps and ventilation will be effected through an inclined raise from the far end of the pump chamber, with a crosscut from this driven just above the roof elevation of the sumps.

Hoisting at Central and "B" Shafts

At Central shaft two hoists exactly similar in size and make are installed. One handles the rock in balanced skips and the other the man cage with a skip as a counterbalance. The latter skip is also used for hoisting spillage from below the loading pocket.

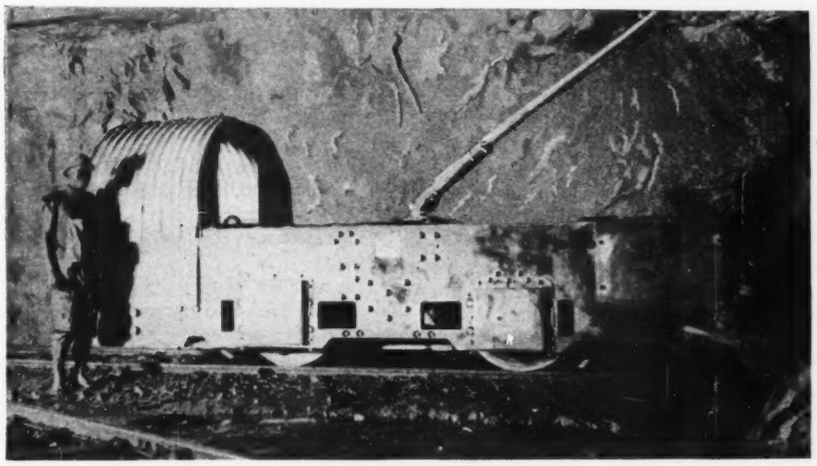
Both hoists are manufactured by Metropolitan Vickers and are driven by 1,350-hp. d.c. motors. They have cylindrical drums 13 ft. in diameter and capable of operating to 2,500-ft. depth. The braking system is of the hydraulic oil-pressure type and hoists are fitted with Lilly safety controls. Ropes used are $1\frac{3}{4}$ in. in diameter and the hoisting speed is 1,500 ft. per minute.

"B" shaft hoist, manufactured by Metropolitan Vickers, is driven by a 425-hp. a.c. motor. It has cylindrical drums 10 ft. in diameter with a capacity for 2,100 ft. of $1\frac{1}{2}$-in. rope. Braking and safety devices are the same as those at Central shaft, and the rope speed is 1,000 ft. per minute. Cost of hoisting is given in Table VII.

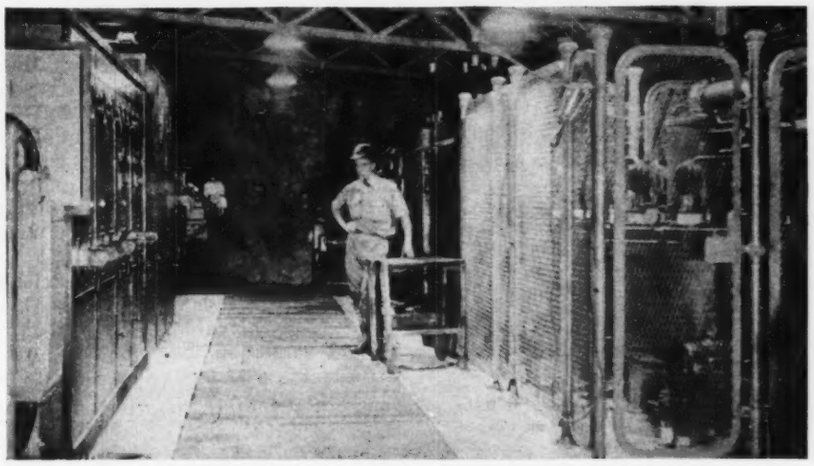
Table VII—Cost per Ton of Ore Hoisted

	Shillings	
Hoisting	0.24	$0.06
Shaft maintenance	0.03	$0.01
	0.27	$0.07

ORE HAULAGE at Nkana. One of the 13-ton Jeffrey trolley locomotives. Standard 180-cu.ft. Granby-type mine cars are hauled in trains of nine to the main grizzlies, where they are dumped



MAIN SUBSTATION at Central shaft on 600-ft. level of Nkana mine. Here a.c. power, brought underground at 3,300 volts, is stepped down to 550 volts for use in pumping and scraper work



Power Facts

Alternating current power at 3,300 volts is taken down "B" shaft and No. 4 incline to the 900-ft. level. Substations with transformers are erected on the 450- and 600-ft. levels at Central shaft and on the 900-ft. level at "B" shaft and No. 4 incline. Power is stepped down to 550 volts in substations and supplied to the pumps and scrapers. The 750-ft. level is supplied from the 900-ft. level substation up "B" shaft.

Some power for the scrapers on the upper levels is brought down at 550 volts from the surface through the incline shafts. The supply taken down "B" shaft is led through two main cables with link boxes on each level, so that any section can be isolated without interfering with it.

Most of the pumps in the mine are driven by 550-volt motors. Those at No. 4 incline on the 900-ft. level, however, take power at 3,300 volts direct. The new pumping station at "B" shaft on the 1,290-ft. level will also take power at this voltage. The majority of the pumps are arranged to be started and stopped by natives. On the 550-volt motors Star Delta or autotransformer starters are used. On the 3,300-volt motors remote-control autotransformer starters are used and where the motors have wound rotors liquid starters are employed.

For the electric locomotives power is taken from the 600-ft. level substation, where it is transformed and then converted in Brown Boveri mercury arc rectifiers. Direct current at 500 volts is distributed from the substation through "B" shaft to all levels.

Power for stope scrapers is supplied at 550 volts. A main supply cable is led through the scraping section, feeder cables being taken off the main cable up the service ladderways. Star Delta

switches are used for starting the motors.

To deliver power for development scrapers an armored cable is led to within 300 ft. of the face and connected to a Reyrolle gate and switch. From here delivery to the scraper is effected by means of a trailer cable carried on a drum on the back of the scraper. A Star Delta starter is mounted on the scraper within the operator's reach.

For the storage-battery locomotives charging sets are arranged for native supervision, automatic charging panels being employed. Ampere-hour meters are fitted to each locomotive, which trip the charging supply when the battery is fully charged.

Voltage for all lights is 110, single-phase lighting transformers being installed where required. Floodlights are installed in the scraping stopes, each containing two 1,000-watt lamps. Each floodlight has its own lighting transformer fed from the same supply as the scraper hoist.

Sharpening Steel

All drill steel is sharpened by the hot milling process and tempered in salt baths with automatic temperature control. It is distributed to storage on the various levels, whence it is issued and checked by natives. Sizes and kinds are as follows: For main haulageways, 1¼-in. round lug; for stoping and sublevel drifting, 1-in. tappet hex; for sinking, 1-in. collar hex.; and for stoping, ⅞-in. collar hex.

All explosives used are manufactured in South Africa by the African Explosives & Industries, Ltd. Gelignite is used in all blasting operations, in the following strengths and sizes: For development, 60 per cent 1¼x8 in. and 1x8 in.; for stoping, 40 per cent 1¼x8 in. and 1x8 in.; and for secondary blasting, 40 per cent ⅞x4 in.

No blasting is done electrically. Bickford Smith fuse is used exclusively. All fuses are cut to the required lengths and capped on the surface, the lengths being indicated by dipping the ends into different colored dyes. Igniters supplied by African Explosives are used for spitting all fuses.

Extensive mine workshops are maintained, where material such as skips, cages, scrapers and scraper slides, steel chutes, and grizzlies are made.

Underground Personnel

All drilling and blasting are done on day shift and all mucking of development ends on the night shift. Tramming and stope scraping are carried out on three shifts in some stopes and on two shifts in others.

The mine superintendent, who has charge of the Mindola mine as well as the Nkana mine, has a general mine foreman, five mine captains, an underground mechanical engineer, and approximately twenty shift bosses under him. Total underground personnel consists of approximately 200 white men and 3,000 natives.

The mine has been divided into three stoping and two development sections, with a mine captain in charge of each. Captains work on day shift only and usually have two day-shift bosses and two night-shift bosses under them. Day- and night-shift bosses do not change shifts. There is a safety officer and also an official who acts as native supervisor and looks after the handling and distribution of all underground natives.

Each miner runs six machines in a stope with a native crew of twenty. A scraper man looks after the scraping and grizzlies in two or three stopes and has a crew of about fifteen natives. In main haulage development a miner runs one end with three machines in the face and a crew of thirteen natives. One development scraper man looks after the mucking of the end with a crew of about twelve natives.

Miners on sublevel development run six ends with a native crew of twenty, and one night-shift "lasher" looks after the lashing or mucking of about eighteen ends, with three natives to a face.

Timber men have each a crew of six boys. Trammer bosses have two or three trains under them, with twelve to twenty-four natives. Electricians, riggers, and fitters are attached to each mine captain's section and work under the rigger, electrical, and mechanical bosses.

All miners work on a contract system based on tons broken or footage advanced, with a day's wage guaranteed. In stoping an extra bonus is paid for low powder consumption. In development work miners have the contract price reduced if a certain fixed footage per case of powder is not reached.

Development scraper men are paid a bonus on the footage advanced in the haulageway. Stope scraping is on contract and includes the working of the grizzlies.

The mine shuts down on Saturdays at 3.30 p.m. until 3.30 p.m. on Sunday, and only urgent work is carried out during the week-end.

Table VIII—Costs of Material Landed in Northern Rhodesia

	Shillings per Cubic Foot	
Pitch pine	8.75	$2.13
Oregon pine	5.00	$1.22
Cement (95-lb. bags)	4.25	$1.03
Rails, 45-lb. per complete mile of track	£2,230	$10,853.00
Structural steel, per pound	2½d.	$0.05
Drill steel, per pound	5½d.	$0.11
Powder, 40% Gelignite per 50-lb. case	33s.	$8.03
Powder, 60% Gelignite per 50-lb. case	39s.	$9.49

All costs have been converted at the rate of $4.866 to the pound sterling.

HEADQUARTERS of the Rhodesia Anglo American and Rhokana Corporation at Nkana

The Native Workman

Before the mines started in Northern Rhodesia the local native was totally unused to steady work of any kind. Regular feeding and good living conditions have made a marked improvement in his general physique, even in the short time the mines have been running.

The number of native workers available is ample, and provided they are kept on the same type of work and properly supervised they become remarkably efficient. An issue of hot cocoa and bread is made immediately the shift is ended.

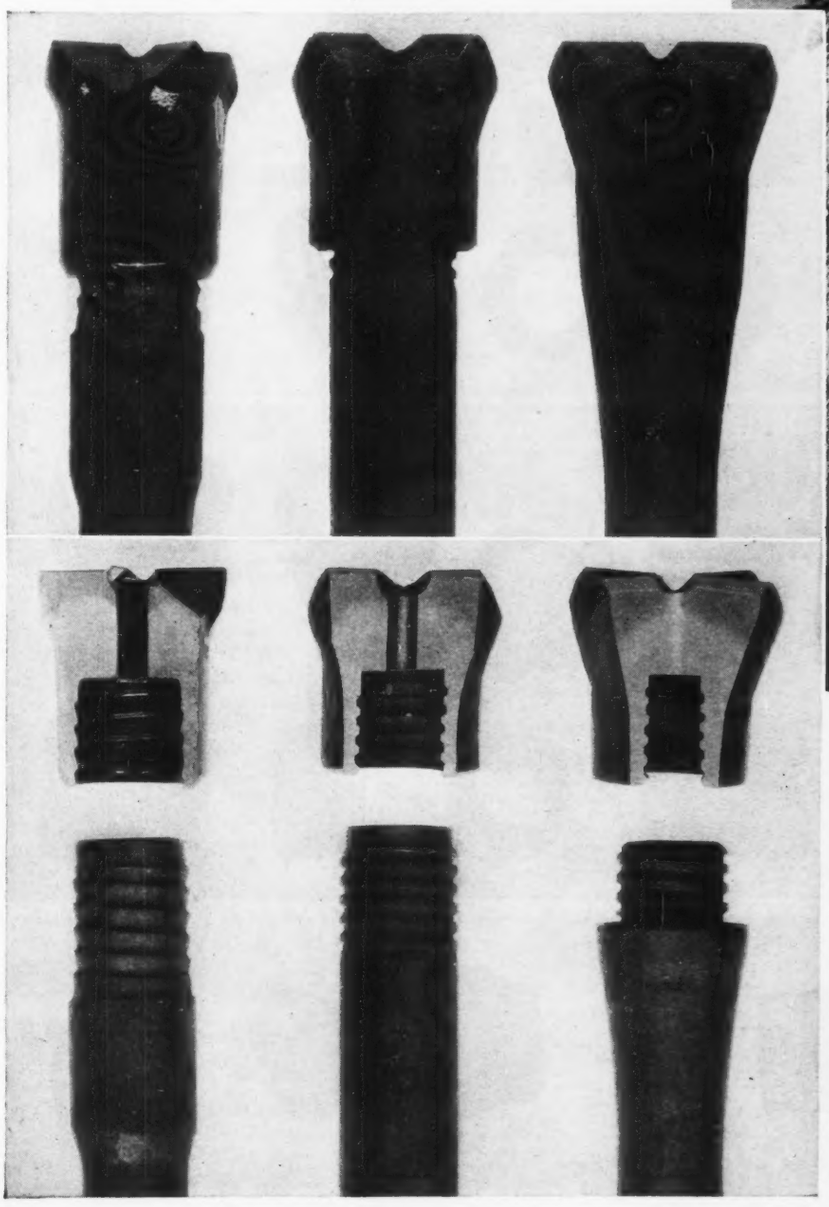
All machines are run by natives; they also drive trolley locomotives, are left in charge of pumps, operate tugger hoists on the service raises, and drive all scraper hoists. The best of them are selected from the gangs and undergo a course of training at the native training school run by the safety officer. They are taught the use of various types of machines, the handling of explosives, and first-aid work. When proficient, they are examined by the Mines Inspector for a government blasting license. Natives who so qualify do all the blasting on grizzlies and assist miners in scaling-down operations and in blasting at the end of the respective shifts.

As "hook worm" is prevalent among the natives throughout Northern Rhodesia, particular care is paid to underground sanitation.

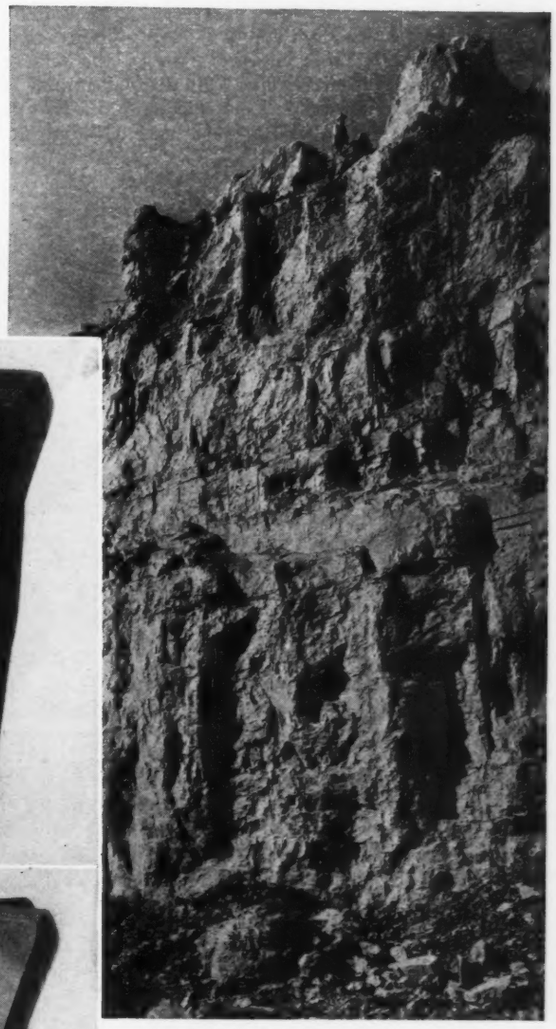
Costs of certain supplies landed in Northern Rhodesia are given in Table VIII. They will serve as a standard for comparison.

Cost and Performance Data on Forged and Detachable Bits

Drilling in Siliceous Dolomite at Norris Dam Quarry Demonstrates Economy of Detachable Bits, Due Mainly to Greater Speed and Ease of Handling Steel



THREE TYPES. Detachable bits used in the Norris Dam tests, shown in cut-away section and in assembled form



QUARRY FACE. Siliceous dolomite at Norris Dam on which five one-month test runs of forged and detachable bits were made

TO OBTAIN a comparison of costs and operating performance between detachable and forged drill bits in rock drilling, the Tennessee Valley Authority last winter and spring conducted a series of tests at the quarry for Norris Dam, near Knoxville, Tenn. The tests covered complete quarry operations for five months, and were supervised by special inspectors who observed and recorded the costs and performance characteristics of the drill steel. Forged bits, regular equipment on the job, were used during the first month. In each of the succeeding three months all drills were equipped with

one of three makes of detachable bits. Forged bits were again used during the fifth month, but under more favorable drilling conditions than prevailed during the four preceding tests. The results indicate that for large quarry operations under conditions obtaining at Norris Dam, detachable bits are cheaper, largely because their harder and sharper cutting edges result in faster drilling, and because of the saving in steel-handling costs.

The following data are extracted from a report prepared by A. J. Ackerman, construction plant engineer, Tennessee Valley Authority, who initiated the tests. Manufacturers of detachable bits rendered useful advisory service throughout.

Quarry and Drilling Conditions

The quarry at Norris Dam is benched into a steep hillside. Quarrying operations extended along a 1,000-ft. face which, during the tests, ranged from 60 to 80 ft. in height. The rock is a siliceous dolomite, between trap and sandstone in toughness. Its abrasive qualities are lower than those of granite or trap, but above most limestone, dolomites, slates, and shales.

Quarrying was by the bench method. One, two, or three rows of holes were drilled parallel to the face on 6x8-ft. spacing, and sufficient powder was used to throw the blasted rock clear of the face of the newly formed bench. Drilling 10 ft. per bit was possible, permitting the use of 10-, 20-, and 30-ft. steel of 1¼-in. hollow-round rods. Quarrying operations were conducted 22 hours per day, six days a week.

Thirteen wagon-mounted drills of four standard makes were used indiscriminately during the tests, four or five being in service at one time. Shop equipment included a sharpener, an oil furnace, and a shank grinder. Air supply was from a 6-in. header, which divided into 2- and 4-in. feeder lines. Drills were connected to the feeders by 50-ft. lengths of 1-in. hose. Several checks of air pressure at the drills and at the header line, where it entered the quarry, showed not more than 2 lb. difference in pressure.

The usual crew for each shift on the detachable-bit tests consisted of: one blacksmith and helper, one drill operator and helper per drill, one nipper, two cribbers, a drill foreman, and a water boy. For the forged-bit runs the same personnel was used, plus an additional helper in the shop, another nipper, and a truck or team. When detachable bits were used, one man transported the used and sharp bits between shop and drills, and the driller's helper changed the bits on the rods. Two men were required for collecting and loading used forged steel, transporting it to and unloading at the shop, and loading, transporting, and distributing fresh steel. On the high quarry faces three or four additional men were required to carry the steel up to the drills.

In making the tests each type of bit was used exclusively for one month. Daily records were compiled and later reduced to a final summary representing average conditions of the many variables that occur in the quarrying operations. All holes were measured when completed, but no record was obtained of the footage of holes partly drilled and abandoned when the steel broke or stuck. Holes nearly completed at the time of breakage of a bit were usually loaded and fired.

An important difference should be

CHARACTERISTIC BREAKAGE. Fragments of these bits show portions where fracturing is most common

noted in respect to gages used on the forged and detachable bits. The gage of the forged bits was 2½ in. on the 10-ft. steel, 2¼ in. on the 20-ft. and 2 in. on the 30-ft. The same gages were used for detachable bits during the first two weeks; for the following ten weeks a ⅛-in. differential in gage was used (sizes 2¼, 2⅛, 2 in. for six weeks, 2½, 2⅜, 2¼ in. for the last four weeks).

Unavoidable variations included changes in drill-crew personnel, rock and drilling conditions, air pressure, time required for moving and cribbing up of wagon drills, distance from shop to drills, number of rods available for detachable bits, and experience of the drilling and sharpening crews in the use of detachable bits.

Though the tests were conducted in such manner as to provide as true a comparison as possible, the variations stated in the foregoing naturally affected the results to a certain extent. The inexperience of the crews during the first part of the detachable-bit runs was a handicap to this type of drill steel. Because the tests were conducted under similar drilling and rock conditions, results of the first forged-bit runs and those of the detachable units are fairly comparable; a switch from the quarry bench to the solid rock floor for the second forged-bit test introduced drilling factors not comparable with those prevailing on the other tests.

Results of the test are summarized in the accompanying table. The three runs on detachable bits are treated as one test to give a direct comparison between them and forged bits.

Forged-Bit Tests

Two of the five one-month runs were on conventional forged bits. A comparison of results of these two runs reveals variations as wide as those between forged and detachable bits. These are largely attributed to differences in drilling and rock conditions, but they indicate the difficulty in conducting a drilling test under truly comparable conditions. The first test was conducted on the quarry bench, whereas operations for the second forged-bit test were transferred to the floor of the quarry to remove a 30-ft. layer of rock. Here nipping of drill steel was reduced to a minimum, handling expense was low, and steel was easily changed before becoming too dull.

On the first run the cost of transporting the steel between shop and drills, up and down the steep quarry face, and handling at the sharpener was a large item. In the last, drills were handled on the level floor, the shop was much nearer the point of operations, the steels were changed more often, and hence the rate of drilling was better.

In the first test, the number of stuck steels was high. The principal cause of sticking was found to be a failure to enlarge the blowhole sufficiently during sharpening operations, thereby reducing the air supply for blowing out cuttings. Sticking was also caused by unequal hardening of the bits, resulting in excessive gage wear. Breakage of shanks and steel was considered normal. In the second test, sticking of bits and steel breakage were much lower, attributed to harder rock containing fewer loose seams.

Little breakage of the bits of the forged units occurred in either test. Bits were sharpened without any mechanical control of heating or tempering. Considering that the removable bits were all heat-treated by scientific methods, the breakage and wearing qualities of the forged bits were regarded as very satisfactory.

Detachable-Bit Tests

Tests on three makes of detachable bits were made over a period of three successive months, one make of bit being used exclusively over the entire quarry for one month. (In the following discussion the tests will be referred to as 2, 3, and 4.) All operations were completely converted in one day to the use of the detachable bit. As there was no advance training of the crews, the first test undoubtedly suffered by reason of the lack of experience of the men and because of the two-weeks' use of ¼-in. differential in bit gages, later changed to ⅛ in.

Rod Performance—At the start of Test 2, 30 rods were prepared, but excessive steel and thread breakage due to continuous hard performance required the number to be increased eventually to 62. Had more rods been available at first, the high rod breakage might have been reduced because of lower fatigue stresses. For Test 3, 81 rods were prepared, resulting in better performance, and based upon this experience 94 were made ready for Test 4.

The three types of detachable bits required different types of thread on the end of the rod. One type required upsetting the end of the rod in preparation of the threads, which proved to be a difficult and expensive operation. Equipment for this process included a forge, a sharpening machine, and a lathe, and, as the lathe shop at Norris Dam is a mile away from the sharpening shop, steel transportation costs were high. Another type of bit required a lathe-cut thread, also found to be expensive to form. A forging process was developed to replace the lathe work, which proved to be much more satisfactory, for the threads could be formed in the drill shop and the forging of the steel seemed to reduce rod breakage through the thread. However, both a forge and sharpening machine were required for the operation.

Threading Simple and Cheap

The simplest and least expensive form of thread was made with a hand-operated die, by which the thread was formed and the rod end shaped in one operation. Except for the die, the only equipment required in this operation was a forge.

Breakage of the rods was high, especially in Tests 2 and 3, occurring through the threads in most cases, due to pounding of the bits in removing them from the rods, faulty heat-treatment, fatigue, and possibly insufficient area of the cross-section through the threads. Subsequent improvement in heat-treatment reduced the rod breakage considerably. In Test 4, rod breakage was small, but bit breakage was high, the bit giving way before the rod under excessive strains.

It was rather surprising to find that practically as much rod steel was consumed with detachable bits as with forged bits (Table Item 27). The more intensive use of the detachable-bit rods, resulting in high fatigue

Performance and Cost Data—Norris Dam Drill-Bit Tests

Item	Test No. / Type of Bit	1 Forged	2, 3, 4 Detachable	5 Forged
	Summary of Work and Time			
1.	Rock excav., cu.yd.	57,647	217,273	81,392
2.	Lin.ft. holes drilled	27,099	130,253	69,042
3.	Lin.ft. drilled per cu.yd.	0.471	0.599	0.848
4.	Total drilling time, hr.	1,488	6,104	3,200
5.	Lost time, hung steel, hr.	60	237	95
6.	Lost time, moving, hr.	374	1,281	469
7.	Lost time, other losses, hr.	128	466	194
8.	Net drilling time, hr.	926	4,020	2,443
9.	Ratio of net to gross time	0.623	0.659	0.763
	Consumption of Steel and Bits			
10.	Rods used	120	219	195
11.	Rod metal consumed, lb.	2,750	13,134	4,152
12.	New bits used	.....	4,454	.....
13.	Bits reground once	.....	3,680	.....
14.	Bits reground twice	.....	2,320	.....
15.	Bits reground three times	.....	708	.....
16.	Bits reground four times	.....	36	.....
17.	Fresh points used, total	1,913	11,198	6,688
	Loss and Breakage of Rods and Bits			
18.	Rods broken	17	83	14
19.	Shanks broken	6	37	5
20.	Bits broken	.....	461	.....
21.	Threads broken	.....	207	.....
22.	Rods stuck	69	58	16
23.	Losses, total	92	846	35
24.	Losses per 1,000 points	48.1	75.6	5.2
	Performance and Losses per 1,000 feet of Drilling			
25.	New bits used	.....	34.2	.....
26.	Fresh points, incl. regrinds	70.6	85.9	96.8
27.	Rod consumed, lb.	101.5	100.9	60.1
28.	Rods broken	0.63	0.64	0.20
29.	Shanks broken	0.22	0.28	0.07
30.	Bits broken	.....	3.54	.....
31.	Threads broken	.....	1.59	.....
32.	Rods stuck	2.55	0.45	0.23
33.	Losses, total	3.40	6.50	0.50
	Drilling Rate			
34.	Drilling rate, ft. per hr.	29.24	32.80	28.26
35.	Drilling, ft. per fresh point	14.17	11.63	10.32
	Costs, Cents per Foot			
36.	Drilling cost	8.86	8.19	9.17
37.	Shop cost	2.40	0.99	1.05
38.	Nipping cost	3.36	0.52	1.34
39.	Material cost(a)	1.13	2.09	0.69
40.	Total cost per ft (b)	15.75	11.79	12.25
	(a) Cost each, new detachable bits: Gage, in.	2	2¼ 2½ 2¾ 2⅞	
	Cost, cents	26	27 28 30 31	

(a) Cost, 1¼-in. hollow drill steel: 47½c. per ft.
(b) Does not include superintendence.

stresses, accounts for the heavy rod consumption. Furthermore, every time a bit broke the rod became battered and had to be cut off and re-threaded.

Detachable-Bit Performance—One of the difficulties the inexperienced crew had to overcome was removal of the bits from the rods. All through Test 2, a heavy hammer was used to loosen the bit, resulting in much breakage of both bit and rod. In Tests 3 and 4 a more satisfactory method of removal was adopted; the bit was rested on a rail serving as an anvil, and the collar was struck a few blows with a light hammer. A blow on one of the lugs then usually loosened the bit. A few drops of oil on the thread facilitated bit removal.

Breakage of the bits varied with type. One type had excessive breakage through relatively thin walls, which resulted in heavy rod losses also, for every breakage caused a battering of threads, which required cutting off the rod to form new threads. Another type of bit stood up well, but its design was such that rod breakage through the threads was common. The third type of bit showed little breakage.

Possibilities of regrinding and retempering the detachable bits were thoroughly investigated. In Tests 2 and 3 the grinders were inexperienced, and ground off more hardened material than probably was necessary. These bits wore well after the first regrinding, but battered badly thereafter. Later experience indicated these bits to be good for two regrindings with proper work. A greater depth of hardening and experience in regrinding resulted in much better sharpening results in Test 4; the bits stood up well after two regrindings.

Sticking of rods in Tests 2, 3, and 4 was much lower than in the first forged-bit run, but somewhat higher than for the second forged-bit test. Drilling through a seam or loose rock was the principal cause of sticking. Better blowing facilities of the detachable bits kept the holes clear of cuttings and reduced the hanging up of steel. Very few of the hung rods could be unscrewed from the detachable bits, for, especially on long rods, it was impossible in most cases to apply sufficient force to loosen the bit, and often the bit turned with the rod.

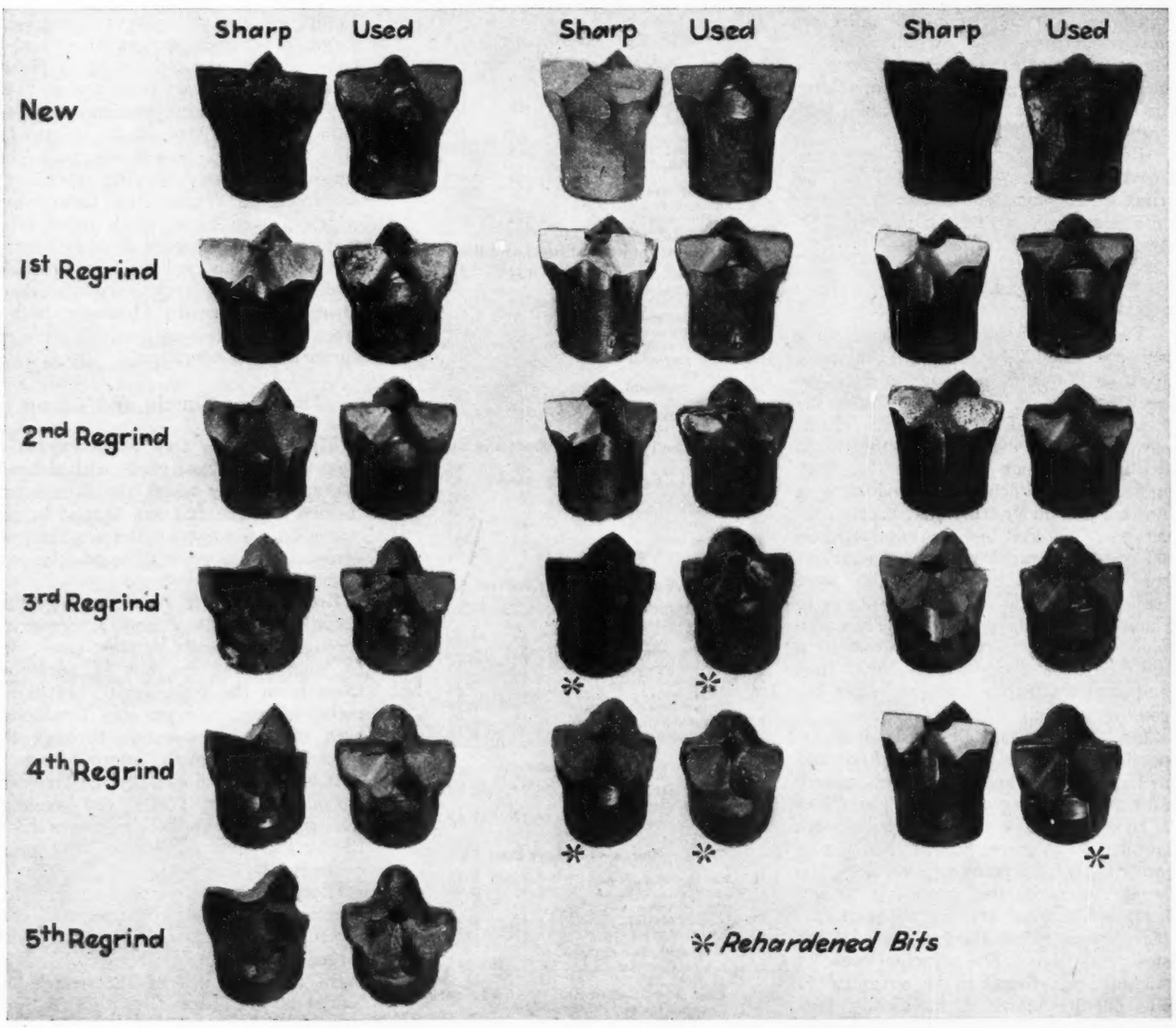
The report draws the general conclusion that detachable bits proved more economical for Norris quarry conditions. Cost per foot of hole drilled by the detachable bits averaged less than that by forged bits even under favorable conditions. Other conclusions stated in the report follow:

Under the conditions existing in the Norris Dam quarry not much difference was disclosed in the relative merits of the various makes of detachable bits, assuming that the high breakage of one type can be overcome by changes in design.

The removal of bits from the rods is not a serious problem. Oil applied to the threads helps to keep the bits from binding.

It is not possible to recover all rods

(Continued on page 30)



BEFORE AND AFTER. Appearance of detachable bits, new, reground, and used

Critical Observations of

Mineral Behavior

When Associated With

Superheated Water

Arthur J. Crowley

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Los Angeles, Calif.

THAT the phenomenon which is the subject of this article may, with a more thorough understanding of its behavior, be found to function importantly in the processes of mineral depositions seems possible. Up to this time, observations of it have been confined to its influence on one particular non-metallic—sulphur.

It is granted, in the absence of evidence of its influence upon other metals and minerals, that the possibility exists that it is germane to the only one upon which its influence has been noted; however, in the specific case it provides a more satisfactory explanation, to me at least, of certain peculiarities existing in mineralized zones where sulphur is the dominant mineral; moreover, it provides a solution for certain hitherto mysterious characteristics of processes by means of which commercial quantities of sulphur are obtained from the Louisiana and Texas deposits, and from the comparatively superficial deposits in Utah, Nevada, California and other localities.

The Frasch process, which is employed in obtaining production of the major part of world requirements of sulphur, delivers a product which is 99 to 99.9 per cent pure. The process was a magnificent conception. It is entirely possible that Dr. Frasch had observed the subject phenomenon, and that it constituted an element of design in his plan. Consideration of the physical conditions encountered in the producing operations of the Frasch process by which the sulphur-bearing formations are treated *in situ*, and of the conditions existing in those operations where the ore is treated after being mined, warrant the conclusion that the non-existence of the phenomenon would have produced a different result. Hypothesis, fortunately in this instance, need serve only as a background; concrete evidence is available, and if description does not provide satisfaction, it may be obtained at the cost of slight effort.

Sulphur liquefies at an average temperature of 241 deg. F. Under ordinary conditions almost any substance—sand, sawdust, metal dust, cotton, and many other materials—will mix readily with liquid sulphur, and, upon solidifying, the mixture becomes a concrete mass. If a stone or an "Alundum" filter plate is heated, and the temperature raised to that of the melting point of sulphur, the liquid will pass through the filter freely. At 250 deg. F. the viscosity of sulphur is approximately the same as that of water. To approach a similitude, liquid sulphur passing through, or touching, loose substances becomes contaminated in transit. Liquid sulphur at a temperature according to its lowest viscosity has approximately the same pulp factor or coefficient as water. It has a specific gravity of 2.

Cores taken from the Louisiana and Texas sulphur-bearing formations consist of friable limestone, through which elemental sulphur is disseminated. Removal of the sulphur by liquefaction would cause disintegration of the core. During certain periods of the Frasch operations, sand has been used to replace the disturbed material and to retain the integrity of the caprock which lies above the sulphur-bearing formation. In many locations there are ample surface indications of subsidence. It is obvious, therefore, that there is a period in the operation during which not only the sulphur, but its physical associates, are free to move, and do move. Logically, they should move in the same direction; there are conducive factors: the area is flooded with superheated water, which has entered under a super-imposed pump pressure of 350 lb. per square inch; there is gravitation to the sump, which is the terminal of the concentric group of pipes which functions to supply superheated water to the sulphur formation, to maintain temperature around the sulphur delivery pipes, and, in some instances, to provide air for pumping the product to the surface.

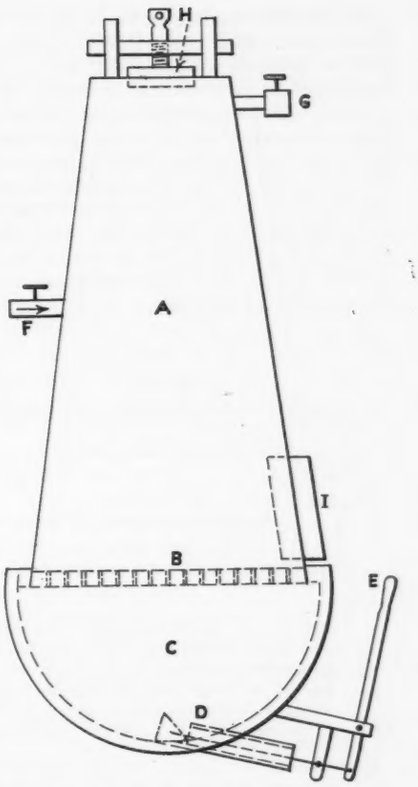


Fig. 1. . . . SULPHUR LIQUEFIER of the type used in Utah, Nevada, and California. Constructed of cast iron, to operate under 50-lb. pressure, it has a capacity of 2½ tons of mine-run ore. "A" represents ore space; "B," a cast-iron grate, perforated at 3-in. intervals by ¾-in. holes; "C," a jacketed bowl in which sulphur, liquefied by the application of steam, is collected as it drops from the ore; "D," a simple cast-iron cone-valve, connected to a rod which passes through a steam-heated conveyor pipe to an operating lever "E." This valve is held on its seat by internal steam pressure. "F," steam supply pipe; "G," steam exhaust pipe; "H," removable head of ore entry; "I," ore discharge door

The natural factors are now to be restated and their relation to the foregoing ones considered. The specific gravity of the liquid sulphur is 2. The specific gravity of the gangue is generally higher than that of sulphur. Sulphur mixes readily with gangue material. The sum total is a conclusion that the liquid sulphur, on its way to the surface, is a vehicle eminently suited to the purpose of conveying its associate materials.

It is not unreasonable to conclude that unless governed by other factors the product of the Frasch process might be expected to contain a very high percentage of contaminating solids.

Consideration is now to be given to the situation as it exists under different general conditions, but where the same fundamentals govern. It concerns operations for the extraction of sulphur from ores in which it is in elemental form, and which have been mined and are processed in a plant—a separate operation; one which has been performed in many localities during the past fifty years, and which is now in use in Inyo County, Calif., in a plant designed and constructed by myself.

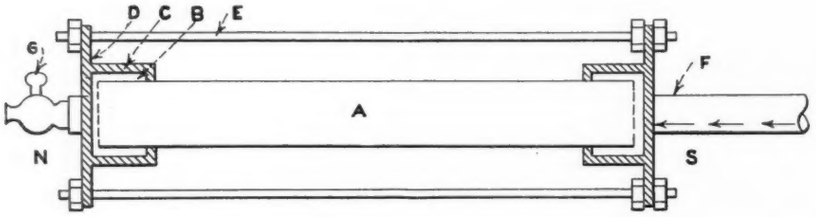


Fig. 2. . . . LABORATORY APPARATUS for the purpose of permitting observation of the behavior of sulphur in association with superheated water consisting of "A," 1-in. diameter pyrex glass tube, 14-in. in length, supported at each end by rubber gaskets "B," which are supported in gland sheaths "C," mounted on frames "D," the assembly being held together by distance rods "E." "F" is superheated water line, "G" the discharge valve

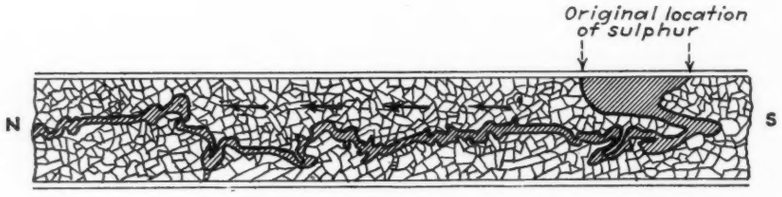


Fig. 3. . . . ENLARGED SECTION of the glass tube "A," showing the course of the sulphur as it shot through the mass of rock and fines

The process, as a whole, is not particularly efficient; its employment is warranted only when high-grade ore, which is subject to very low mining costs, is available. The product is of high quality, 99.99 per cent pure, but the percentage of the sulphur extracted from the ore is very low. It might be said, in passing, that it is the only process which has permitted profitable production operation, in the United States, of the surface type of sulphur deposits. It was in operation, under my supervision, at Sulphur, Nev., in 1917. In detail, the operation comprises the following procedures:

Mine-run ore is dumped onto the grate *B* (Fig. 1); head *H* is replaced, steam is turned in through *F*; pressure of 45 lb. is maintained for 30 min. Valve *C* is partly opened, and liquid sulphur is discharged and run into molds. It is a 99.9 per cent pure product. Steam is then exhausted through *G*. Door *I* is opened, and the residue is raked out and sent to the dump. When ore is dumped into the liquefier, it falls a distance of 6 ft. to the grate. Upon impact, some shattering of the friable ores occurs, and particles pass through the $\frac{3}{8}$-in. holes. Fines included in the charge also pass. The angle of repose of the ore is high, and without further cause there will be no additional movement. However, as soon as the head is securely fastened in place, saturated steam is introduced, which, contacting the cold air, condenses. Additional condensate occurs as the result of the lowered temperature, due to expansion of the steam. The condensate flushes some of the fines from the ore mass, down into the collecting bowl. That this occurs is evidenced by a trickle of a fines and water slurry, past the sulphur discharge cone valve, which does not seat tightly until pressure has built up in the liquefier. When the gage pressure reaches 9.86 lb., the temperature is 240 deg. F., and the sulphur is melting. It moves swiftly, being as fluid as, and twice the weight of, water. Obviously, it flushes fines and small rocks, freed from the ore lumps by the departure of the binder, sulphur.

It is a fact that if liquid sulphur and other materials are mixed in the open air, or in a dry atmosphere, separation of them is extremely difficult. It is also a fact that if mediums other than steam, or superheated water, were used for the heat transfer, in a liquefier, the product would be a mixture of sulphur and gangue. Therefore, in addition to liquefaction, another phenomenal separation has taken place.

The earlier description of the liquefier operation was brief and concluded with the act of drawing off the 99.9 per cent pure sulphur. The description was suspended at that point in order that the conditions in the liquefier might be visualized, in view of an extraordinary circumstance which follows the discharge of the pure sulphur. It is followed by a slurry of water, sand, rocks, nails, and other débris which have been included with the ore. With the exception of water, and perhaps small wood chips, the solid material of the slurry is of greater specific gravity than the liquid sulphur. Thus far two commercial processes have been described, and it has been established that they function phenomenally. It appears that they disobey some natural laws, unless such laws are in abeyance to an unrecognized law.

Types of Sulphur Deposits

Some geological situations, in which it is indicated that the same phenomenal circumstances have occurred, will be described. Inasmuch as the situations are common to many of the sulphur-bearing areas which I have observed —namely, Sulphur, Humboldt County, Nev.; Thermopolis, Wyoming; Inyo County, Calif.; and the deposit near San Felipe, Bajo California—the descriptions will be of a rather general nature. Though the nature of the major geological features varies greatly in the various regions adjacent to the sulphur-bearing areas, there is a similarity of conditions, appearances, and physical characteristics in the immediate vicinity of, and on, the sulphur-bearing zones.

The sulphur deposits appear to occur in fairly definite trend along a zone of weakness, within a general area of compact and massive formations. In and about the sulphur deposits are many evidences of earlier thermal activity. The deposition of sulphur, in some part of each of the general areas, is satisfactorily explained by the theory of ascending hot gases cooling at, or near, the surface. At this time the source of the gases is not of importance. In these occurrences the sulphur, ash, and rock form a concrete mass. Some of the ores of the Inyo County, Calif., deposits consist of 60 to 90 per cent sulphur and 40 to 10 per cent silica of an almost impalpable fineness.

There is, however, a type of deposit which is not satisfactorily explained by the foregoing theory. In general it consists of a compact mass of pure sulphur surrounded on all sides by unlike material. In some occurrences the encompassing material is hard, tough, siliceous conglomerate, entirely barren of sulphur; in others, it consists of a finely divided free-running silica—locally termed ash; or again it may be a mixture, or consist of ore having a varied gangue constitutent cemented by sulphur, in which the percentage of sulphur may be 10 or 80 per cent. Individually the occurrences conform to no

particular shape—they may be thin, horizontal, flat strata from an inch to many feet in width and length; or, as at the Crater group of deposits in Inyo County, Calif., in an almost vertical vein, 150 ft. in depth, from 2 ft. to 20 ft. in thickness, and several hundred feet in length. At Sulphur, Nev., pure sulphur was found in huge, kidney-shaped masses, and at this location one of the masses, known as the China mine, has been only partly mined.

Had these occurrences been in cavities in hard, unaltered formations, the usual theory of deposition would be acceptable, but those in this reference are often in loose, unconsolidated material, or in material which may have been unconsolidated at the time of deposition, and later concreted by sulphur.

Behavior Phenomenon

These occurrences do not conform with the known behavior of liquid sulphur when in contact with other materials. If a quantity of liquid sulphur is poured onto the material surrounding these pure masses it will, until lowered temperature causes solidification, seep into, and be absorbed by, the material, or will absorb the material. Confirmation of this is found in the results of experimental work performed by Texas Gulf Sulphur Company, by myself and others, in which concrete, wood, and other substances have been thoroughly impregnated with sulphur.

I have observed in the laboratory a phenomenon which comes into play, certainly, to account for the condition extant in the Louisiana and Texas operations, and in the surface treatment plant described, and very probably to account for the freakish conditions discernible on the various deposits. Stated briefly, the phenomenon is that when liquid sulphur is in contact with superheated water, it, while retaining its fluidity, acquires an extraordinary capacity of mass cohesion, or quality of surface tension. It is possible that neither the term "capacity of mass cohesion" nor "surface tension" is applicable, but it is not necessary to modify the qualifying adjective, "extraordinary."

It certainly functions nobly in the instance of the Frasch process, in which superheated water is used, and in that of the surface-treatment plant, where it has the condensate from the steam supplied for liquefaction, and which constitutes superheated water. This water collects in the steam-jacketed bowl. The descending liquid sulphur displaces it, and ultimately the water is resting on the liquid sulphur. The gangue and débris—even those fragments or portions having superior specific gravity—float upon the sulphur.

Fortunately, it is an extremely simple matter to make crude demonstrations of the functioning of the phenomenon, and two simple experiments will be described at this juncture, which, it is believed, determine the phenomenon to be a powerful, positive force, such as would be necessary to account for its extraordinary behavior under conditions which have been observed and will later be described, and which, for duplication, require more intricate and costly apparatus.

Experiment No. 1—The apparatus consists of a piece of standard pipe; it may be of any diameter, but it is suggested that it be at least 1½ in. and not less than 12 in. in length, threaded at both ends and furnished with caps or plugs. It should be capable of holding an internal pressure of 100 lb.

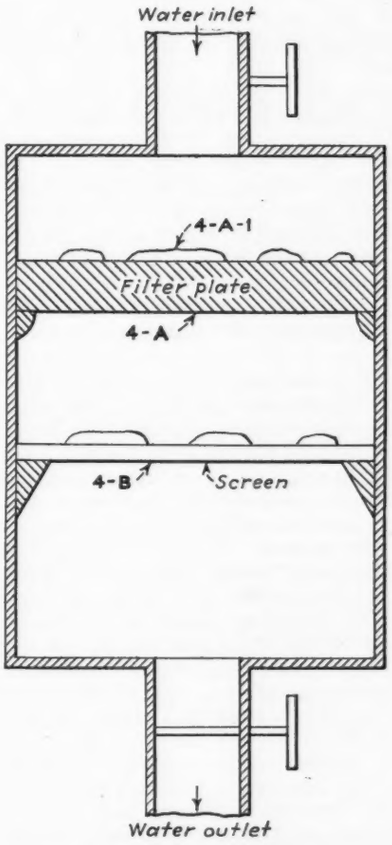


Fig. 4. . . . PRESSURE CHAMBER constructed to permit circulation of superheated water. No. 4-A represents filter plate 1-in. thick. No. 4 A-1 represents globules of sulphur. The filter plate is capable of passing 10 gal. of liquid sulphur per square foot per minute in open air or under dry conditions

In this apparatus, for the first experiment, place sufficient of a dry mixture of sulphur and other substances (solids) to half fill it. Use your own judgment about closing the apparatus with caps or plugs or leaving it open—the result will be the same. Apply sufficient external heat to liquefy the sulphur. Upon cooling, and solidifying, the product will be a concrete mass.

Experiment No. 2—Use the same apparatus. Use sufficient of the dry mix, used in the first experiment, or the product of it, broken into pieces small enough to go into the apparatus, to fill approximately one-third of the interior; then add sufficient water to fill. The caps, or plugs, should be tightly closed. Then apply external heat until the internal temperature is in excess of 245 deg. F. This can be ascertained by applying sulphur to the external surface; if it melts on all the surfaces it is safe to assume that the necessary internal temperature has been reached. Localization of heat must be guarded against, regardless of the size of the apparatus, and sufficient time must be allowed for liquefaction of the lumps.

In practice it has been found advisable to rotate, or agitate, the apparatus. Rolling it on the floor is good practice, as violent agitation does not affect the result. Cool the apparatus thoroughly before removing the caps or plugs.

Examination of the contents will show that the sulphur has coalesced, completely excluding the other substances, although some particles may be entrapped at the surface of the sulphur. In such instances it will be found that the partly submerged portion of the particle is irregular in shape, and has permitted partial enfoldment by the sulphur. There will be no evidence of integral cohesion. Usually, when the contents are discharged from the apparatus, the foreign substances are carried out by the water, and are followed by the solidified globules, or masses of sulphur, which, upon analysis, disregarding, of course, any superficially entrapped material, will be found to be practically pure.

Detail of Tests

Some observations made in the course of research work, the objective of which was the development of a process for the more complete extraction of the sulphur content of the Nevada ores, and one whereby 86 per cent sulphur flotation concentrates of these ores could be filtered, or otherwise reduced, to commercial grade—99.5 per cent sulphur—will now be described.

Glass Tube *A* (Fig. 2) is filled with sulphur ore, or with sulphur and various solid substances; superheated water is admitted, and if cooled upon contact with the tube and its contents, is exhausted through valve *G* until the tube is filled with water of sufficient temperature to cause liquefaction of the sulphur.

The particular purpose of this apparatus was to solve the problem involved in the failure to function of a rather costly plant which was an enlargement of an extremely successful laboratory plant. Search for answers to the problem, however, led to recognition of the subject phenomenon.

The tube was almost filled with rock, broken to pass through 8-mesh screen, the charge including crushed fines. Near end *S* several lumps of sul-

phur were placed. It was necessary to discharge some of the superheated water, which was then supplied and had cooled upon contact with the charge, but the discharge valve *G* was carefully throttled to avoid creating velocities within the tube.

Upon melting, the liquid sulphur did not follow a gravitated course and flow toward end *N*, which was slightly lower then end *S*. It hung in a largy, sloppy globule, cumbersomely draped about the adjacent solids. In responding to changes of the angle of the tube, its movement had the ponderous ductility of a jellyfish. This situation was held under observation for a few minutes, when the possibility of cooling occurred to me and impelled a sudden, and rather clumsy, opening of valve *G* to permit a fresh flow of superheated water through end *S*.

A streak of yellow lightning sped a tortuous course through the tube, and the globule had vanished, passed out of valve *G*, shattering into minute globules as the superheated water exploded into vapor upon its release from pressure. A fresh charge of sulphur was supplied and the experiment repeated, but in this instance the discharge valve was handled with great tenderness. This gesture of respect was rewarded. The dark irregular area represents the form taken, and the course followed by the liquid sulphur, as the result of removing the pressure from a face of the sulphur globule, by causing the water to move toward end *N*, by opening valve *G*.

It is difficult to show, by means of a sketch, the real situation. By opening valve *G* and closing it almost instantly, it was possible to halt the sulphur in transit through the tube, and eventually to ascertain that the contact of water with the sulphur was broken. In other words, the superheated water was at one point of contact with the sulphur removed faster than it was replaced, and the surface tension destroyed.

When movement was once started the entire globule behaved as a silk cocoon being unspun; it ran in a single, unbroken thread, through an irregular system of voids in the solids within the tube. When the voids were enlarged, the thread expanded, forcing the water out; in many instances, where the solids were loose, they were moved until they made firm contacts. The globule remained intact during its passage through the solids, even when its course was over hills and sometimes through undercuts. At times it was necessary for it to pass through spaces not much larger than the eye of a needle.

It should be understood that all of the surfaces of the solids were wet, and that unless valve *G* was opened sufficiently to create a high velocity movement of the water, nothing would occur. Halting the sulphur for observation was quite a tricky job. It is again remarked that the angle of the apparatus did not affect the situation.

Later it was demonstrated that it was possible to send a charge of sulphur through many feet of solids by the application of the foregoing conditions.

On the filter plate (Fig. 4) was placed a lump of sulphur 1 in. x 1 in. x 1 in. (a 1-in. cube), and some smaller pieces. The pressure chamber was closed, and cool water supplied until the chamber was filled; the water was gradually displaced by superheated water. Eventually the water pressure was raised to 300 lb. per square inch, and it was then permitted to cool. None of the sulphur had passed into or through the filter plate, and no cohesion had taken place. The solidified globules were approximately 3/16 in. in thickness. No. 4-B represents a No. 10 mesh screen properly supported. The same results were obtained; the globules remained on the screen. Many other observations of the phenomenon have been made, but it seems that the foregoing should serve to permit visualization.

Laboratory Conditions in Nature

It seems possible, upon consideration of the situation described in the glass-tube experiments, that the depositions of pure sulphur found in Nevada, Utah, California, and some other localities, may be accounted for by the existence of similar conditions in the past, in those regions: A magma of sulphur, superheated water, sudden surface weakness, a globule of sulphur entrapped in an ascending column of water, cooling of the water and loss of velocity, due to expansion in the weak zone, consequent and instant solidifying of the surface and perhaps a continued flow of the water with concretionary matter in solution, resulting in the cementation of the surrounding material, or perhaps, its alteration. The subject localities indicate that all of the necessary conditions have existed.

It is not difficult to believe that conditions prevail, and have prevailed, under which superheated water of temperatures sufficiently high to melt other minerals and metals can exist. Specific reference may be made to the interesting operations of The Geysers Development Company, at The Geysers, in Sonoma County, Calif., which are the subject of Carnegie Institute of Washington Publication No. 378, "Steam Wells and Other Thermal Activity at 'The Geysers,' California," by E. T. Allen and Arthur L. Day. On page 84 of this report is a description of tests which determined the existence of temperatures of 450 deg. F. at a depth of 250 ft. in one of the wells drilled for the purpose of obtaining natural steam.

Recognition of the possibility of such conditions permits speculation as to whether or not the subject phenomenon acts in the presence of superheated water and minerals, other than sulphur; and whether or not, under such conditions, do all the minerals retain individuality, or are some of them affinitive, and not subject to the phenomenon, in their relation to each other?

Finally, is it a reasonable flight of imagination to conceive the possibility of vein filling, in some instances, being the result of transportation, under the influence of the phenomenon from a deep-seated source, immediately following surface fissuring, with its consequent zonal weakening?

Forged and Detachable Bits

(Continued from page 26)

in the event of stuck bits. The bits may turn with the rod, but not come up.

Assuming that most drill rods are developed to suit the conventional drilling and tempering requirements of forged bits, it may be possible to reduce rod breakage by modifying the characteristics of the steel to suit detachable-bit service.

Transportation and handling of steel is a heavy cost factor in the use of forged bits. The second forged-bit test indicated that when this cost can be held down, drilling with forged bits might be as economical as with detachable bits.

Comments

Throughout the report are numerous interesting comments resulting from observations rather than from test data. Some of these follow:

No tests were made of the metallurgical characteristics of the various types of detachable bits, but in general their metallurgy appeared superior to that of forged bits.

A passive resistance to the use of detachable bits was noticed on the part of the drill sharpeners, apparently because of fear of being replaced. However, the sharpeners can be used to advantage for regrinding and retempering the bits, though this work demands a certain skill on the part of the operator. At Norris the majority of bits were used three times. More skill and experience in grinding and tempering probably would have increased the use of bits to five or even six times.

The high loss of rods with detachable bits is not generally realized. It is believed that by keeping more threaded rods available fatigue stresses will be reduced and greater footage per rod will be obtained.

The tests were made almost a year ago, and in the meantime the bit manufacturers have been improving their product. A similar series of tests today might show different results. It is believed there are possibilities of improving the technique of making and using detachable bits which may lead to their more universal adoption.

NEWS
OF THE INDUSTRY

Domestic Silver Price Remains Unchanged As World Quotation Falls

Revision of United States Silver-Buying Policy in "Public Interest," Says Morgenthau

MAINTAINING a world market price of 65⅜c. an ounce from Aug. 15 to Dec. 7 under apparently steady marketing conditions, silver became an object of discussion and uncertainty early in December, due to change in the silver-buying policy of the United States Treasury. This altered policy has not affected the domestic price for newly mined silver, which remains at 77.57c. per ounce.

On Dec. 9, London bullion brokers offered for sale 3,000,000 oz. of silver from the East. The Treasury came into the market late that day, but failed to buy the full amount offered. As a consequence the price fell to 28¾d. and to 64¼c. in New York. This change of procedure on the part of the Treasury caused uncertainty, and the following day 5,000,000 oz. of spot silver were offered and 15,000,000 for future delivery. The Treasury offered to buy 2,000,000 oz. at a quotation of 28⅜d. This was not accepted, because the price set for each day is to be for all silver offered on that day. The Treasury's bid was rejected, and no London quotation was made, but the New York price dropped to 63¾c.

On Dec. 11 about 6,000,000 oz. were available, and the Treasury offered to buy 450,000 oz., or about 7½ per cent of the total. The London dealers decided to change their regulations and the bid was accepted and sales were prorated among the sellers, with a price of 27½d. in London and 62¾c. in New York. On Dec. 12 the Treasury bought only 18 per cent of the total 5,500,000 oz. offered, with a consequent further drop to 26⅞d. and to 61¾c., New York. Lack of information concerning the reasons behind the Treasury's change of silver-buying policy created comment concerning the future of the Silver Purchasing Act. On Dec. 12 Secretary Morgenthau made the following statement:

> "I am continuing to carry out the mandate of the Silver Purchase Act, which says: 'The Secretary of the Treasury is authorized and directed to purchase silver at home or abroad, for present or future delivery, with any direct obligations, coin, or currency of the United States authorized by law or with any funds in the Treasury not otherwise appropriated at such rates, and at such times, or on such terms and conditions as he may deem reasonable and most advantageous to the public interest.' "

Secretary Morgenthau indicated that he was still buying silver but "in many different places," and that this constituted a change in policy. He made it clear that his position against the repeal of the 50 per cent tax on speculative silver profits was unchanged.

During November the purchases of silver were the largest for any single month since the silver-buying program began. About 5,000,000 oz. of domestic newly mined silver were bought and 104,200,000 oz. were purchased in the world market.

In the first part of November, 1935, the Chinese Government announced that currency reforms were effective. It ruled that all debts in terms of silver were to be discharged by payment in legal-tender notes and that all silver bullion and coins must be turned in to the government or the holders would be prosecuted. The export duty on silver was raised from 14½ per cent to 65 per cent, which was also aimed at smuggling that had been going on for a long time. Previously, notes were accepted and exchanged for silver and the resultant smuggling activities are said to have netted as high as 40 per cent profit in the world market. Following the revision of monetary policy nothing was said by Chinese officials to indicate that silver, gold, pound sterling, or the yen would support the new paper money, thereby apparently leaving it with unknown stability. They are reported to have stated that the notes would have ample backing in pegging the Chinese dollar to some foreign currency.

Silver has been used in China for centuries, and the people are reluctant to substitute paper money for their silver coins. Since the Chinese Government announced that it had not planned to dump its huge stocks of silver on the world market, some circles believed that China would ultimately revalue its silver. The whole situation resolves itself to one of money and is beset with conflicting and unknown forces, among which is the Japanese intervention in North China and her investments amounting to more than a billion yen in China. Japan, therefore, is looked upon by some interests as exerting a marked influence in the Far Eastern situation.

Silver circles here regard the present policy of silver buying as a necessary move whose objective is to frustrate schemes for supporting and expanding managed currency groups at the expense of the United States dollar. The price fell 8/16d. from Dec. 9 to 24, but toward the end of December the situation appeared to become less tense in London, as the quotation rose ⅛d. while the New York price remained unchanged at 49¾c.

A statement on Dec. 26 from United States Senator Key Pittman, of Nevada, advises that he approves the Treasury's manner of buying silver and the lowering of the price. He stated: "There are monetary and exchange factors involved which justify the present course. I am satisfied that Secretary of Treasury Morgenthau is conducting the purchase program satisfactorily." Senator Pittman also expressed his belief that China will abandon its attempt of a managed currency and return to a silver standard.

Mill Construction in Arizona Follows Development of Several Mines

Plans for a 50-Ton Custom Ore Plant in the Chloride District Being Made by Arizona Magma Mining Company—Development and Exploration Work Continues at Toughnut Mine—Tungsten Concentrates From Hereford

IMMEDIATE CONSTRUCTION of a 50-ton custom milling plant for the Chloride district to relieve the excess tonnage on the present company plant is being planned by the Arizona Magma Mining Company. The company placed its own mill in operation the middle of August and has been running steadily, handling some of the ores from the neighborhood mines. The new unit is estimated to cost $50,000 and should be completed and operating by March 1, according to Cliff T. Carpenter, of Phœnix. A. C. Dundas is mill superintendent at Chloride.

✦ American Kirkland Gold Mines, at Willow Springs, is considering installation of a 50-ton mill instead of the 30-ton mill as previously planned, in view of the recent mine development. Connection with the electric line of the Arizona Power Company instead of installation of diesel equipment is also under consideration. According to Dr. Hugo A. Carl, field engineer, Prescott, two shafts are now being sunk.

✦ Three carloads of machinery for initial work on mill construction have been sent to the Swastika Mines, Inc., at Cleator. Regular shipments of silver ore have been made for several months during mine development. D. S. Carpenter is assistant general manager and O. I. Tawney, mine superintendent.

✦ A ⅜-yd. Universal power shovel has been installed at the Harqua Hala Cyanide Mill, at Salome, to load tailings for transport by truck to the mill. The lessees have also installed a cable bucketway to facilitate loading and discharging the tanks. These two improvements will bring the capacity to 80 tons daily. Production for the current year will put Harqua Hala in the 1,000-oz. class. W. C. Kinnon is superintendent and metallurgist and Herman Swadley, mill foreman. The operation is directed by Miles M. Carpenter, of Tucson.

✦ Approximately 2,500 ft. of development work has been opened in the Toughnut mine at Tombstone, since it was leased from Tombstone Development by United States Smelting, Refining & Mining eighteen months ago. Ore is being stoped for regular shipments while exploration work is in progress on the 500-ft. level. E. P. Jeanes is superintendent.

✦ Oatman Eastern has doubled the output of the Ruth-Rattan mine to 120 tons daily. The ore is sent to both the Tom Reed and the Telluride mills. Work is directed by James J. Moss, president.

✦ Milling operations are to be resumed at Monte Christo Gold-Silver Company's property at Constellation, according to an announcement by Frank D. Kimball, the company's new president.

✦ Regular shipments of high-grade gold ore are being made to the Magma smelter from the Waterman and Johnson lease. The property is located on the west slope of the Mazatzal range, 38 miles from Payson, 70 miles from Phoenix, in a district recently made accessible by the completion of the Bush highway. The orebody is developed by a 250-ft. tunnel, 160 ft. deep at the end. Sheldon Waterman and Stanley Johnson, both of Mesa, leased the property from T. L. Daniel, who has been prospecting for 30 years in that part of Arizona.

✦ The first mill operation of Gold, Silver & Tungsten, Inc., at Hereford, yielded table concentrates at 76 per cent scheelite, jigs above 60, and middlings of 40 to 45 per cent. The mill is similar to the company's plant in Boulder County, Colo. Ore is mined principally from the King lode. The company is headed by J. G. Clark, of Boulder. Its Arizona operations are directed by C. G. Sewell, mine superintendent, and Thomas Bailey, mill superintendent.

✦ The Vulture mine, Wickenburg, is quarrying ore from the unmined part of the vein as feed to a 125-ton amalgamation and flotation mill, while operating a 100-ton cyanide plant on tailings. The work is directed by D. C. Finlayson and A. B. Peach.

Argonaut Mining, in California, Planning Modernization of Mill

Ball-Mill Grinding and Flotation Process of Gold Recovery May Replace Stamps and Amalgamation Tables—Dragline Dredge Operators Studying Recovery of Fine Gold Lost in Tailings—Survey With WPA Funds Halted

ACCORDING to a communication received from Alex. F. Ross, superintendent of the Argonaut Mining Company at Jackson, plans are being drawn to change the present amalgamation-concentration mill over to a ball-mill and flotation process to handle the present daily maximum of nearly 300 tons. During the past 2½ years a new orebody has been found further south of the then known orebodies as a result of solving the No. 2 and No. 3 south faults. This vein is now being worked on the 5,800, 5,700, and 5,550 levels, and indications are that it will be found soon on the 5,400 level. The bulk of production is received from the 6,000 level. Ore broken from the new orebody has about the same milling value as that mined from the older known veins. The present mill contains 60 stamps, with amalgamation tables and several banks of concentrating tables and vanners. At the adjoining property, the Kennedy, mining operations have been resumed after completing repairs in the main shaft, which necessitated a shutdown of several weeks. The mill and the 1,000-ton tailings plant are reported to be operating satisfactorily.

✦ Operators of dragline dredges have slowed up production to study recovery of fine gold lost in the tailings, according to a report from Lincoln. Application of flotation methods is said to have brought good results at several properties. If a successful recovery method can be found much of the land already dredged will be reworked. Operators in the Lincoln area include the Virginia Placer Company, Sherman Tharpe, manager; Fay Placers, E. M. Kaufield, president; Lincoln Gold Dredging Company, controlled by Oroville interests; Oakwood Placer Mining Company, H. B. Eden, superintendent; and the operation of C. N. Chittenden.

✦ Placer deposits comprising about 900 acres of land between Folsom and Orangevale along the American River have been purchased by A. V. Bechtel, of the W. A. Bechtel Company, San Francisco, one of the companies that built Hoover Dam. The gravel is to be mined by open-pit methods, with a steam shovel capable of handling 2,500 cu.yd. per day. The digging and gravel-washing operations are to be conducted on a two-shift basis.

✦ Mining activities continue to expand in the Forbestown district, Butte County. Idaho Maryland Mines is reported to have acquired the Garibaldi claim in addition to the Gold Bank and King Midas properties now being

equipped and developed under the supervision of Harold Lynn, superintendent. The company plans to continue development work during the winter months, employing a large crew of men at the various units under the direction of J. E. Ehrhorn, the resident superintendent.

✦ A transaction involving the acquisition of the old Oro Fino mine, in the Auburn-Ophir district, Placer County, by the Oro Fino Consolidated Mines Company, a syndicate composed of San Francisco and Nevada County mining interests, has been announced by J. C. Kemp van Ee, secretary, Mining Association of California. Preliminary work on the 400-acre holdings near Ophir will include unwatering the 840-ft. shaft and erection of surface buildings. Installation of a mill and other plant equipment is contemplated upon completion of this work. The mine has been idle for over fourteen years and is credited with a production of $1,000,000 in gold.

✦ The survey of California's mineral resources which was to have been undertaken with WPA funds by a newly created agency known as the California State Mining Board came to a sudden halt recently. The United States Bureau of Mines is said to have objected to the proposal to send questionnaires to mining men in the State from which the State Mining Board could prepare data for the more comprehensive survey. Initial funds for this work were to be a WPA appropriation of $13,000 and the completion of the program would have involved an expenditure estimated at $250,000. The survey organization had been established for almost a month when the stop order was given on Dec. 20. The State of California maintains a State Department of Natural Resources which has a Division of Mines with headquarters in San Francisco and the United States Bureau of Mines also has representation in the State.

✦ Control of the Aetna mine, near Nevada City, is said to have been acquired by the Wiljobar Corporation, John D. Bardill, president, operating the Frederic property, formerly known as the Hussey, in Willow Valley. Development work contemplated at the Aetna mine includes sinking of the shaft to the 125-ft. level and driving of drifts into new territory. G. M. Bettles is in charge of operations.

✦ J. Alden Armstrong and associates, of New York City, through Charles H. Segerstrom, president of Carson Hill Gold Mining Corporation, have secured a lease and option on the noted Soulsby mine, near Soulsbyville, and rehabilitation work is to start at an early date. The property was a steady producer of high-grade ore for many years and was once owned by the Bagdad-Chase Mining Company, controlled by the late Chauncey Depew.

Ore-Roasting Operations Started At Manning Gold Mines in Utah

Equipment Formerly Used at Marysvale for Reducing Alunite Ore Will Now be Used for Tailings Treatment—Sheba Gold Mines Company Taken Over by Halifax Tonopah—High-Grade Copper Ore Shipped From Mountain City

FIRES were started about Dec. 15 under the roaster installed at the Manning plant, near the old camp of Ophir, and the treatment of ore was initiated. Formerly used for roasting alunite ore at Marysvale, the roaster is expected to treat about 250 tons daily. Ore from the Lewiston Peak mine will be roasted as well as tailings from the Mercur dumps. The shaft of the Lewiston Peak Mines has been sunk about 480 ft. and is going down at the rate of 100 ft. a month.

✦ After pumping water from the 1,050-ft. level of the Park City Consolidated Mines Company, the company has started cutting a station to prospect the Silver fissure. A connection is also being made between the East Crescent and the Silver fissure on the 900 level to accomplish the drainage of the East Crescent.

✦ Advancing metal prices have stimulated activity in the vicinity of Marysvale. The Annie Laurie mine and mill, at Kimberly, are employing 75 men. Regular shipments are being made from the Deer Trail by eighteen groups of leasers.

✦ Control of the Sheba Gold Mines Company's property at Ibapah, western Tooele County, was passed to the Halifax Tonopah Mining Company with George Fuerman, of Reno, acting for the Halifax company and E. H. Havenor, of Salt Lake City, for the Sheba company. The new company is to be called the Queen of Sheba Mining Company. In exchange for control, the Halifax Tonopah Mining Company agrees to spend $52,000 in development work of the long-idle property, which had a production of $100,000 many years ago.

✦ Shipments from the Mountain City Copper mine of the International Smelting Company at Mountain City, Elko, Nev., are reported to have carried ore averaging as high as 33 per cent copper. The product, which is hauled by truck to Elko, a distance of 90 miles, is being taken from the high-grade chalcopyrite deposit on the 300 level. Ore is shipped to the Tooele, Utah, plant of the International Smelting Company for treatment.

Headframe of the Frisco Silver Lead Mining Company near Milford, Utah. High-grade silver-lead carbonate ore was struck recently on 250-ft. level

✦ The Utah Bunker Hill Mining Company has resumed development of its property in the Free Coinage district in the Stansbury range, Tooele County. Two groups of leasers are operating from the Dove tunnel and making occasional shipments.

✦ The Little May Mining Company is driving the lower tunnel in its Box Elder County property, to open up ore developed in the upper levels, according to John Matson, manager.

Tungsten Production in Nevada Likely to Increase During 1936

Nevada-Massachusetts Company Has Remodeled and Enlarged Its Old Mill in Mineral County for Production of Tungsten Concentrates—Climax Molybdenum Has Option on Deposits Near Goodsprings

TWO NOTABLE PRODUCERS of tungsten are now operated by the Nevada-Massachusetts Company, Inc., the largest American producer of this metal. An old mill on the company's Silver Dyke mine, in Mineral County, has been remodeled and enlarged and a 10-mile pipe line assures an adequate water supply. Concentrate shipments will soon start from this 100-ton plant. Near Mill City, in Pershing County; the principal operation continues to increase development of tonnage, and the main shaft has been sunk below 1,000 ft. Important additional reserves are said to have been proved by diamond drills. The mill at this point is treating 250 tons of ore per day, the concentrate going to a refinery in Pennsylvania. Ott F. Heizer, of Mill City, Nev., is manager of both properties.

✦ Delamar, virtually abandoned for some 30 years, credited with $25,000,000 gold production and situated 32 miles southwest of Caliente, Lincoln County, is again assuming importance in its output of gold from leases and from the 100-ton cyanide plant of the Caliente Cyanide Company, treating both ore and tailing at the old Delamar mine.

✦ Climax Molybdenum Company, operating in Lake County, Colo., has taken under option of purchase and is developing the Fredericksson-Springer molybdenite deposit southwest of Goodsprings, southern Clark County. The owners have been producing a small volume of high-grade concentrate in an outmoded mill, now enlarged and adequately equipped by the Climax company, which is said to have established the presence of substantial reserves and has shipped 85 per cent concentrate. Climax is partly owned by American Metal Company, Ltd., which has lately acquired a 10 per cent interest in Consolidated Coppermines Corporation of Kimberly.

✦ The first contract for construction of a proposed power line from Boulder Dam to the Pioche district in southeastern Nevada has been let, involving a stretch of line nearest to Pioche. Pledges of funds have been obtained in sufficient volume to insure the completion of the line, according to J. H. Buehler, manager for the Snyder interests, of Salt Lake City, principal operators in the productive district. A loan and grant from the PWA of over $900,000 gave assurance that the large orebodies blocked in the district would be developed.

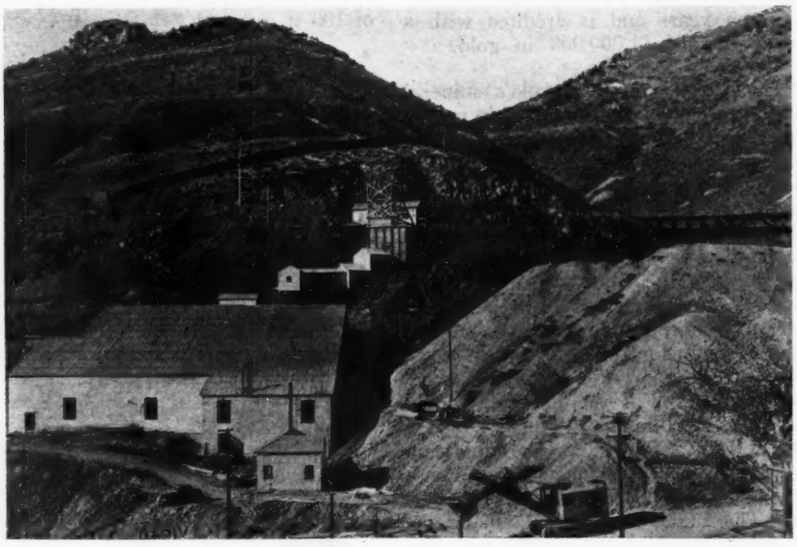
✦ A 100-ton cyanide mill, designed by Albert Silver, of Tonopah, has been completed near the Mary mine, at Silver Peak, Esmeralda County, operated by the Black Mammoth Consolidated Mines under a ten-year lease from the Pittsburgh Silver Peak Gold Mining Company. An old 50-ton mill near the new plant is being remodeled and will treat custom ore. Fred Vollmar is manager at Silver Peak, Nev.

✦ Formerly an important producer of silver, the Mineral Ridge mine, near Indian Creek, in Lander County, is being reopened, after having been abandoned for many years, by a group of Utah operators, who have organized the Lion Monarch Mining Company to acquire the property. A 270-ft. incline shaft has been reopened and two important orebodies are reported to have been opened, on the 130 and bottom levels. Beowawe, on the Southern Pacific Railroad, is the shipping point, and R. Verne McCullough is president.

✦ At the north end of the Comstock lode the old Central tunnel, in the Ophir mine, is being reopened to reach a point below a body of mill-grade ore developed from an incline shaft near the footwall. Howard W. Squires, engineer in charge, announces that the collar of the long-abandoned 2,200 ft. Ophir shaft is to be cribbed and levels down to the 500 are to be reopened. The Ophir, together with the Mexican and Andes mines, has been absorbed by the Consolidated Virginia in a new merger controlled by John J. Raskob and New York associates.

✦ A small stamp mill with arrastre and amalgamating plates has started crushing ore on the Scossa brothers' gold claims in the Happy Creek district, northern Humboldt County. Discovered early last year by the Scossas, successful prospectors, the NRA claims have produced several shipments of rich gold ore.

✦ Dayton Consolidated, operating the old Dayton mine and 150-ton cyanide mill below Silver City, in the Comstock district, has secured a lease and option of purchase on the old Occidental mine, a mile east of Virginia City on the Brunswick or Occidental lode. Working the mine under lease, Howard W. Squires and associates have made a number of carload shipments of high-grade ore from new stopes above a tunnel first opened in the bonanza period.



New cyanide mill of Sutro Tunnel Coalition, capacity 100 tons per day, on the Crown Point mine, embracing 3,500 ft. of the Comstock lode at Gold Hill, near Virginia City, Nev. The orebody to be mined lies largely under the railroad trestle, now abandoned, the track passing through the long cut in the background and over a 90-ft. fill across Crown Point ravine. Funds for construction of the mill and for changing the rail line were provided by a $160,000 RFC Class A loan

NEWS FROM WASHINGTON

By Special Correspondent

CONGRESS, with the guidance of a Presidential message, this month attacks a set of legislative problems fully as complex as any of recent years. Solution of these is made the more difficult by fear of ballot consequences in November. And there may well be a number of major new problems created by Supreme Court decisions announced during the next few months.

Congressional and Executive activity always seem to be more terrifying to business in an election year. This is particularly unfortunate at a time when industrial revival gives promise of enlarged outlet for the products of mines and quarries. Even the sharpest critics of any particular policy are, therefore, being asked so to guide their action as not unduly to disturb business. Such an appeal, even though it may appear partisan in purpose, is a legitimate one for thoughtful consideration of mining executives.

In judging the trend of legislative, administrative, and judicial action in Washington one must assume that the New Deal, still dominant, has not fundamentally altered its purposes. The means used for reaching desired objectives change, and the amount of noise made by one agency or another may vary; but the major strategy is unaltered. And, also, the major objective of Congressmen, so to legislate as to insure re-election, remains equally unchanged.

Budget Making

President Roosevelt undertook his budget making this year with a very different objective than during the preceding two like efforts. On earlier occasions he clearly wished to make things look as serious as possible in order to secure first $3,300,000,000 and from the last session of Congress the $4,800,000,000. Now, for political reasons, he wishes to make as pleasant a showing for business as is feasible. Furthermore, he knows that Congress has tasted the wild oats of extravagance and will force on him many new items of spending which he does not wish.

Even the President himself could not tell in December, when he prepared his budget for the new Congress, just how the billions of next year's business should be planned. There are four major uncertainties which he even now must face.

1. Veterans' bonus payments will be voted by the next session, but no one yet knows the exact dollar magnitude on which some compromise may be reached by dexterous Presidential maneuvering. At least $1,200,000,000 to a possible $2,200,000,000 will be needed.

2. Processing taxes may be declared unconstitutional by the Supreme Court, in which case some or all of the required $600,000,000 must be secured from other sources, as not even the most stupid political observer of Washington expects that giving of agricultural benefit payments will stop—especially in an election year.

3. The President wants to stop *direct* relief expenditure. Congress will probably force some modified or restricted dole on him. But no one can guess whether this will be a half billion or more. Probably more.

4. Congress will want more WPA-PWA type of spending. It will probably appropriate funds for this purpose. The President will ask for some such funds, but according to present appearances, a smaller total than Congress is expected to grant. Thus he will create for the benefit of business the impression of being economical and try to foist onto Congress the responsibility for extravagance in this pump-priming, now generally in disrepute.

The aggregate of these four uncertainties is approximately $4,000,000,000. Hence precise speculation on other details is not particularly useful. It is enough to say that the President now realizes the desirability and the political expediency of balancing the budget and will make a sincere report in that direction this winter. That in itself is a tremendous progress. Most cuts toward balancing must, however, be in the Alphabetic agencies. The career bureaus and departments have not re-expanded enough since the heavy curtailment of 1931 to 1933 to provide much paring room there. Furthermore, the unthinkable dropping of a whole dozen of such bureaus of that sort would make less difference in the national total than one decision about Passamaquoddy, Grand Coulée, or the like.

Internationalism

December developments in the Italian-Ethiopian controversy have been most discouraging to internationalists in Washington. Most of the growing confidence in the League of Nations as peace maker was destroyed by the weird terms proposed by British and French statesmen as a basis for peace in Africa. Those who previously have been indifferent to League developments were being warmed up almost to enthusiasm for that agency until it had to accept the indirect responsibility for the Hoare-Laval proposals to cede most of the valuable Ethiopian territory to Il Duce.

All this development is of real significance to the mining industry because a major objective in the territorial trading is the control of the mineral resources of Selassie's kingdom. Those best informed in Washington believe that the mineral concession negotiated some months ago with him was far from eliminated as a factor when Secretary Hull secured the agreement of the United States petroleum executives to withdraw. It is suspected that the petroleum companies involved were somewhat more window dressing than basic interests. Certainly no one believes that their appearance of withdrawal in any way cancelled the concession. Metal and mineral groups originally associated with them have, however, not yet chosen to become active proponents of their own cause in Washington.

Keenest critics of all these matters in Washington repeatedly point out that the mineral industries are inherently international in scope, regardless of the political wish of officials. But they also emphasize the fact that political considerations often stimulate or retard commercialization even in countries untroubled by invasion, by civil disturbances, or by the New Deal.

Preserving the neutrality of the United States is proving quite as complicated a job as was expected. The President wishes much wider power to exercise judgment in these matters. He would like to be free to determine when export limitations should be imposed, on what commodities they should be laid, and to what countries they should apply. The fact that copper is widely discussed as one of the commodities in-

No Mine Survey

OWING to changes in the Government policy for work-relief expenditures the Bureau of Mines has been obliged to cancel the nation-wide mine survey that was announced in our November issue, p. 576, and for which a fund of $857,000 had been made available. Hence the industry can now expect no investigation of this type until the new census of mines and quarries, which will soon be initiated in conformity with the usual routine of the regular decennial census.

volved proves that every mineral industry is likely to find itself involved in embargo discussions.

Congress is not disposed to go as far as the President wishes. It will probably prefer to retain in the hands of the legislators full regulation of these matters, even though quick dictatorship handling of various projects might prove a great convenience at times.

The Berry Conferences

A conference of labor and industry called by NRA Industrial Coordinator George H. Berry was a flop; but important developments will come from it just the same. Berry proved an undexterous presiding officer who allowed the machinery of his conference to be so conspicuous as to destroy the appearance of fairness and the opportunity for various parties to take part. This was, for a governmental proceeding, unfortunate. No one would expect any different procedure in a labor gathering or in a meeting of an important trade association which happened to include a few malcontents. But trade gatherings are one thing; a government conference is quite another affair—or should be.

It is not unlikely that industry lost much more than it gained by these meetings. Major Berry convincingly demonstrated that industry had not come with a definite constructive plan. This surprises no one. But its conspicuous proof was almost satisfying enough to the New Deal leaders to make them forget the verbal fisticuffs which occurred. As a consequence, it is confidently expected that some new plan will be formulated and taken to Congress with the explanation that "Business has no program for unemployment relief, so you must take ours."

Among the questions which will be considered in formulating the Administration proposals to Congress are the following thirteen, which have been summarized as the most important received by the coordinator from business and labor groups:

1. Amendment of the Federal Trade Commission Act granting the Commission more authority to meet fair trade practice and working hour requirements.
2. Enactment of a maximum work week law.
3. Enactment of the O'Mahoney bill for licensing and taxation of all corporations in interstate commerce.
4. Modification of the anti-trust laws.
5. Establishment of a Federal subsidy for business as a means of increasing employment.
6. Consideration of the effect upon domestic production of the competition of imports from foreign countries.
7. Establishment of a national industrial organization to concern itself with Federal and State business legislation.
8. Consideration of allocating the jobless to all industries on the basis of normal employment.
9. Encouragement of new industries to absorb the unemployed.
10. Establishment of an industrial council under Federal auspices to promote industrial cooperation.
11. Examination of the taxation question and its relationship to unemployment.
12. Consideration of a national program for training labor, with a view to meeting the shortages developing in many skilled employments.
13. Establishment, under the Census clause of the Constitution, of a system of unemployment censuses, providing a job inventory to be used by a Federal employment office in placing workers.

Employment Records for Social Security Act

THE Treasury Department has issued a Treasury decision concerning records which employers of eight or more will be required to keep under Title IX of the Social Security Act, which becomes effective Jan. 1, 1936. No special form of payroll records is prescribed. Records must be maintained adequate to show the gross payroll and the total taxable payroll, as well as the number of persons employed from time to time. No records of amounts paid to particular employees are required. Employers claiming to be exempt from the tax should keep records to establish their exemption. Requirements under any State unemployment compensation act are not involved in this Treasury decision, copies of which will be available at the Bureau of Internal Revenue and at the offices of all Collectors of Internal Revenue as soon as they can be printed and distributed.

New Law Effects

Money for administration of several new laws will promptly be appropriated by the present Congress. This means more aggressive action of the Social Security agencies, in the administration of the Guffey Coal Act, and many other of the New Deal Alphabetic agencies.

Payroll taxes for social security become effective this month. State and Federal regulations, therefore, require immediate study. But Washington warns that there is no ground for high-pressure sales of new accounting systems. Some publishers of literature and bookkeeping aids can therefore be turned down by mine executives with impunity.

Already in action under the holding companies law, the Securities and Exchange Commission is undertaking to clarify the scope of power utility policy. It has defined what legally constitutes a holding company. Most interesting to mining companies is the fact that enterprises which generate power and sell *some*, may do this without becoming public utilities if the proportion sold and the magnitude of the business in any year is not too great.

Despite lack of special funds for much of its new work, the Federal Trade Commission has kept an open door to all wishing to bring voluntary codes for official review. Up to mid-December only nine such applications had been made. Of these, asbestos manufacturing, and rock and slag wool manufacturing are in the field of mineral products. Other code-seeking industries make fertilizers, asphalt shingles, braided non-elastic materials, solid braided cord, candles, expanded paper or special paper products, and also tobacco products. It is evident, therefore, that only nine relatively small groups out of five hundred active in Blue Eagle days think well of the FTC plan.

Union Split

Mine executives will watch closely the controversy within the American Federation of Labor between industry union and craft union leaders. The resignation of John L. Lewis from the vice-presidency of A. F. of L. shows clearly that he believes this a timely moment at which to start an aggressive drive for industrial organization of unions.

The strength which the movement away from craft organization has shown during the last year or two makes it probable that two great federations will shortly be working for the unionization of industry. The construction crafts whose intercraft controversies have caused so much trouble in the past are primarily to blame for the public disfavor into which the old Federation has fallen. Jurisdictional strikes have been so much more serious, and to the public so much more unjustified, that much practical worker support is expected for the Lewis group of leaders when they approach other industries not now unionized.

Some Washington observers believe that the division of union strength may be an important factor in the character of legislation which Congress will enact this year. This is perhaps true with respect to any such measures as those which concern labor directly. But no one believes that the leaders of either union faction are going to fight each other or waste energy when they wish to exert pressure on Congress with respect to bills having broader social significance. It is quite all right for these groups to fight in family gatherings; but opposition of the outsider will bring united action regardless of organization differences.

Polaris Mining, in Idaho, to Build Mill and Increase Mine Development

Extension of Vein Found Last October on Lowest Level Is Now Developed for 200 Ft.—Plans for a New Mill Being Made in Wallace for Azurite Mines in State of Washington—Liberal King Tunnel Cuts Orebody

THE POLARIS MINING crew of 14 men is to be increased to 30 and a wider scope of development activities will be undertaken under the direction of James F. McCarthy, president of the company, and his engineering staff. Development on the orebody on the 920-ft. level exposes ore totaling 200 ft. along both the east and west drifts. Several hundred tons of ore have been removed in development work and stored. Plans are reported now under way toward the erection of a mill to treat the Polaris ore. The plant may be erected at the mouth of Rosebud Gulch near the railroad and highway and a short distance from the Silver Summit tunnel, through which the ore will be transported from the Polaris vein to the mill, a distance of about two miles underground.

✦ The long tunnel driven through the Silver Summit toward a point beneath the Polaris shaft has penetrated the mountain for 8,800 ft., according to Harry Pearson, president of the Silver Summit company and holder of the tunnel contract. About 2,000 ft. remain, but he expects to complete the work early next spring. At present, using three shifts, the work is being advanced at the rate of 400 ft. per month. The tunnel will reach the Polaris shaft at a depth of 1,040 ft., providing not only a haulage tunnel for Polaris ore, but also ventilation for the entire mine.

✦ The Azurite mine, in the Cascades, operated by the American Smelting & Refining Company, is attracting attention, marking as it does one of the most consistent and extensive exploration programs in any mine in the State of Washington.

Since disclosure of ore on the deep tunnel level, it is reported that upward of $2,000,000 worth of ore is available for treatment. Reports are current that plans for a mill are being drawn by the company's engineers at Wallace, particularly designed to treat the Azurite ore. This work followed months of close study and experiments to determine the best methods of treating the gold-bearing product.

✦ The new four-compartment shaft at the Sunshine mine, now being sunk 3,000 ft., has recently passed the 100-ft. mark and it is expected to go down at the rate of 200 ft. per month under a bonus system. Three shifts are employed, using six machine drills. The shaft has a concrete collar for the first 60 ft. with timbering below that point. Hoisting is maintained with the new large hoist, recently installed.

✦ An extensive exploration program is to be carried out at the Silver Bar gold-silver property, near Kellogg, formerly known as the Eldorado, according to William Ryan, manager, who has been associated with the claims for a number of years. Alex O. Swanson and Solon Clark, both of Spokane, are officers of the new corporation.

✦ The Liberal King gives promise of being in the producing class soon. The deep crosscut tunnel, driven more than 3,000 ft. to reach the vein at a depth of 1,500 ft. below the surface, has disclosed a body of rich lead-silver ore.

Ore is trucked from various shafts in the Oronogo field and loaded on railroad cars for shipment to the Central Mill, in Oklahoma, a distance of 35 miles

Zinc Mines North of Webb City Field, Missouri, to Be Dewatered

Facilities Which Drained the Mines in the Oronogo Section Will Be Moved and Used for Another Pumping Program—Cardin Mining & Milling Company Building a New Mill in Oklahoma—Zinc Production Continues at High Rate

THE DEWATERING program started in the Oronogo bottoms last January by Frank Childress and associates has culminated in the draining of that section of the field in and south of the city of Oronogo, in which such famous old mines as the Oronogo Circle, Mutual and Unity are located. One of the 14-in. Pomona pumps used in the Oronogo campaign has been moved to the north end of the Webb City field, and another one of the 14-in. units may be moved at any time. This campaign will unwater several sections of land north of the north city limits of Webb City and the Oronogo section. Some of the old mines in this section were the Wingfield, Berha A., Mercantile, Ice Plant, Yellow Dog, and Starr.

✦ The Prairie Chicken Mining Company, owned by Henry Hoffman and associates, of Miami, Okla., is building a new tailing mill on the old Northern lease of the Canam Metals Company, northwest of Treece, Kan. The mill will be ready to start soon after Jan. 1. H. D. Youngman will be in charge.

✦ The Cardin Mining & Milling Company, which is operating two tailing mills in the Picher district, has started the construction of a third mill on the Admiralty tailing pile, west of Century, Okla. H. H. Hartzell, of Baxter Springs, is in charge of the building operations. Charles A. Neal, of Miami, is president of the company.

✦ D. C. Denney and associates, of Joplin, are operating the D. & C. mine, 4 miles southeast of Carthage, Mo., and have started dewatering the old Coahuila lease, 3 miles northwest of Carthage. A new mill has just been completed, and leases in Shoal Creek valley, south of Galena, Kan., have been obtained. A new shaft is being sunk on one of the properties, and the company is planning the purchase of equipment for a mill to be erected during the first quarter of 1936.

✦ Mining operations on the Mutual land, owned by Guy Waring, of Webb City, will soon be resumed. It is expected that ore from the Mutual will be shipped to the Central mill around Jan. 1.

✦ The Webb City Lead & Zinc Company, which is operating the old Unity mine, has been shipping around 3,000 tons of crushed ore a week from its lease to the Central mill of the Eagle-Picher Mining & Smelting Company, in Oklahoma. William Cochrane, of Webb City, is the president of the company, and John Skinner, superintendent.

International Nickel Will Increase Smelting Facilities During 1936

Additional Reverberatories and Converters Will Add to the Present Output of Nickel and Copper—Canadian Gold Mining Industry Gains Prominence in Dominion—Ymir Consolidated Closes Mill for Repairs

INTERNATIONAL NICKEL'S recent announcement of additional smelter units (two reverberatories and six converters) costing $6,000,000, to be erected during 1936, is in conformity with the company's policy of keeping its capacity well ahead of current market requirements. The capacity of the present plants is approximately 90,000 tons of nickel and 120,000 tons of copper per annum, and a year from now it will be 126,000 tons of nickel and 168,000 tons of copper. The output of nickel for 1935 will be over 65,000 tons, and the present rate of increase will bring it close to, or past, the annual rate of 90,000 tons by the end of 1936. Falconbridge Nickel is expanding its mine and smelter facilities in similar proportion, though on a more modest scale, its objective for 1936 being 3,000 tons of ore a day.

✦ A considerable part of the Canadian public are now aware of the fact that it is the mines, particularly the gold mines, that have saved the country's credit during the recent difficult years, and that the mines are now in large measure responsible for the present favorable conditions. To this public knowledge must be attributed largely the unusual prominence given the mining industry in the recent conference at Ottawa of the Premiers and Ministers of the Dominion and the various provinces. A few weeks previously, the newly appointed Minister of Mines, the Hon. T. A. Crerar, addressing a gathering of mining men in Winnipeg, had undertaken to examine closely the industry's pressing problems. This was followed by the important annual meeting in Vancouver of the Canadian Institute of Mining and Metallurgy, where a dignified and searching symposium on mine taxation was presented.

The conference in Ottawa decided some important points relating to mining, and the deliberations will be continued under Mr. Crerar's leadership with a view to reaching further agreement.

Quebec

✦ Lamaque, which is now treating 500 tons a day in its enlarged mill, has a monthly output of $200,000, thus equalizing that of its neighbor, Siscoe. Though its ore deposits, like those of Siscoe, are inclined to be somewhat erratic compared with the usual vein type of northern Canada, they have been shown by milling to be both large and numerous, and it is likely the mine will grow rapidly to major dimensions. (Lamaque is a subsidiary of Teck-Hughes, and H. N. Read is resident manager.)

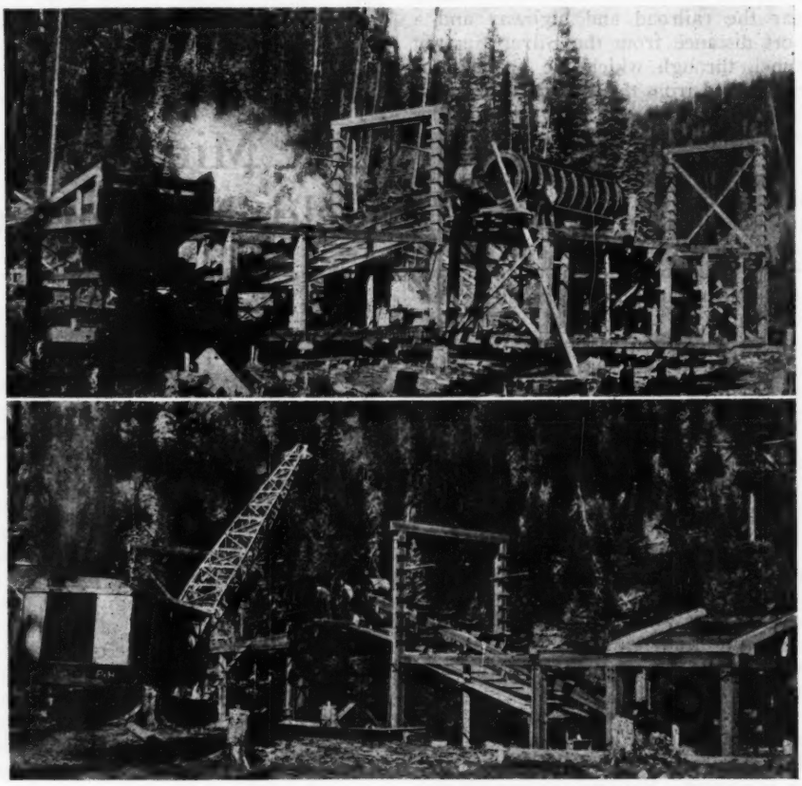
✦ The 25-ton test mill of Perron Gold yielded 729 oz., and a 100-ton mill is under construction. Shawkey has had no production as yet, and its 100-ton mill, now being built, will come into operation sometime during the present year.

✦ The Bussières mine, pioneer of the district along with Siscoe, has not been successful so far and is closed down. Sigma Mines, a subsidiary of Dome, is developing well and promises to repeat the success of Lamaque.

British Columbia

✦ Operation of the 100-ton mill at the Ymir Consolidated has been suspended temporarily to enable repairs and adjustments to be made. The president of the company, R. C. McCorkell, advises that plans are being made to increase the mill capacity to 250 tons. O. D. Frith, of Ymir, B. C., is manager of operations. The orebody found on the third level is being developed.

✦ A mill of 35 tons' daily capacity is now under construction at the property of Vancouver Island Gold Mines, southeast of Alberni. The mill will treat low-grade ore from a shear zone traced on the surface for a distance of 12,000 ft. H. Hoffar is managing director.



Gold recovery on Antler Creek, Cariboo district, British Columbia. Plant of the Antler Gold Mines, Ltd., under construction, comprising Harnischfeger dragline powered in a 125-hp. diesel engine equipped with a 1½-cu.yd. bucket, motor-driven revolving screens, and belt conveyors powered by diesel engine and generator

✦ The new 150-ton mill of Gods Lake Gold is operating steadily on $15 ore. At Jowsey Island, adjoining on the north, shaft-sinking is under way. At Knee Lake three levels are now being opened on both the Knight and the Jowsey properties. Transport by air has been a prominent feature of the discovery and development of these new gold properties.

✦ In 1927 the 150-ton mill of Central Manitoba Mines yielded the first substantial gold output of the province. Since that time the volume of ore has been disappointing, but recently both grade and volume have improved. Gunnar Gold, 5 miles to the east, is now building a 150-ton mill after developing the mine to 750-ft. depth to give an estimated 80,000 tons of $15 ore.

✦ Eighteen miles to the west of central Manitoba is the San Antonio mine, the largest gold mine of the province, whose 300-ton mill now has behind it a disproportionately large reserve of $12 ore above the 1,000-ft. level. Gabrielle, adjoining on the west, was purchased recently by the issue of 75,300 San Antonio shares. This will afford both properties profitable operations as a part of San Antonio, otherwise their existence apart would be questionable. On Forty-Four, adjoining on the east, about 200 ft. of medium-grade ore has been opened in the long drive on the 600 ft. level from San Antonio. Forty-Four is owned by the same group that controls San Antonio. The easiest access to the district is by air, 1½ hours from the air base at Lac du Bonnet.

Calumet & Hecla Raises Miners' Wages

FOLLOWING a wage increase of approximately 11½ per cent, affecting the 1,340 men in its employ, Calumet & Hecla Consolidated has reopened the Ahmeek mine, near Hubbell, Mich., closed since April, 1932. All three shafts of the property will be operated. Although a comparatively small number of men will be employed at the start, the underground force will be enlarged as rapidly as possible. Ocha Potter is superintendent of Ahmeek. The management states that the object of the increase in wages at this time is its desire to meet, as far as possible, the increased cost of living.

Elected Honorary Chairman Of McGraw-Hill

AT A MEETING of the Board of Directors of the McGraw-Hill Publishing Company, Inc., held on December 27, 1935, James H. McGraw, the Founder of the Company and its head for more than fifty years, resigned as Chairman of the Board and was elected Honorary Chairman. He will remain as a member of the Board.

James H. McGraw, Jr., who has been connected with the Company for the past twenty years, was elected Chairman of the Board. He has served as Treasurer and was Executive Vice-President and Vice-Chairman of the Board at the time of his election.

Malcolm Muir, President of the Company since 1928, continues in that capacity.

Mining Districts in Mexico Continue to Be Disturbed by Labor Strikes

Many Companies Grant Concessions and Wage Increases to Miners and One Enterprise Will Allow Employees a 50 per Cent Share in Its Profits—Mazapil Copper Seeking Federal Permission to Suspend Operations

THOUGH hampering labor troubles persisted, many new activities in the Mexican mining industry are reported with the coming of winter. Some companies appeased disgruntled workers by granting wage increases, and one enterprise took the drastic step of allowing employees a 50 per cent share in its profits, an action that is said to be the first of its kind in the history of the Mexican mining industry. The Federal Government announces that it intends to establish a number of small metal-treatment plants in various zones next year to handle ore extracted by miners' cooperative societies, small-scale independent miners, and prospectors.

Wage increases of 50 per cent and other concessions granted by La Mexicana y Anexas, S. A., and the Anite treatment plant at Guanacevi, Durango, settled a labor dispute. Strikers have asked a Mexico City district court for an injunction against the ruling of the Federal Board of Conciliation and Arbitration that their movement against the El Oro unit, Durango, of Cia. Minera de Santa Maria de El Oro, S. A., is illegal. The Federal Labor Board reports that it averted a strike of workmen of the units of Cia. Minera "Dos Estrellas," S. A., at El Oro, Mexico, and Tlalpujahua, Michoacan, by bringing about an agreement between the company and the discontented employees, a feature of which is allowing workers a day off a week with pay.

✦ Four thousand miners, members of the Union of Mining, Metallurgical and Similar Workers of the Mexican Republic, employed by Real del Monte, Dos Carlos and San Rafael Mining companies, operating in the Pachuca zone, Hidalgo, threaten to strike if they do not receive pay for their weekly day off.

✦ Mazapil Copper has asked permission to suspend operations at its Concepcion del Oro unit, Zacatecas, because of difficulties with its workers, who object to a wage reduction of 37½ per cent which the company contends is necessary because of low-grade ore that is being extracted.

✦ Contending that the measure will benefit the mining industry in general, Sonora mining men and the Cananea Chamber of Commerce have asked the finance ministry to amend the Federal mining tax law to increase the minimum amount of production which may be exempt from output imposts. Present minimum output is one gram of gold and 100 grams of silver per ton. It is asked that it be raised to five times these amounts.

✦ Representatives of the Junkerswerke aircraft manufacturing company, of Dressau, Germany, have asked the Federal Government for a concession to operate regular passenger, mail, and express service between Chihuahua City and mines in the Huizopa district, Chihuahua, owned by Gerard Heimpel, who has asked the national government for a permit to build a hangar on his property.

✦ Cia. Minera y Explotadora de Promontorio, S. A., operating near El Oro and Estacion Chinacates, Durango, granted its employees a 50 per cent share in its profits and a say in the management of the enterprise through delegates on the board of directors. These delegates are to receive remuneration equal to that of the directors for board services. Officials of this company aver that the enterprise is earning hardly any profits. It has had much trouble with workers over wages and other matters.

✦ A primary school has been established at Matehuala, San Luis Potosi, by the Asarco Mining Company, in accord with the Federal labor laws which demand that industrial enterprises found and maintain such educational institutions.

✦ The San Francisco Mines of Mexico treated 17,020 metric tons sulphides and 6,730 metric tons oxides during November. Lead concentrates produced 2,820 metric tons. Zinc concentrates produced 1,151 metric tons. All production ceased when the strike commenced on Nov. 16 last. The wage dispute with the workmen at the mine has now been settled, and operations were resumed on Dec. 17.

✦ The Ministry of National Economy announces that miners cooperative societies it organized in Guanajuato are thriving and that it is forming like units in Zacatecas.

✦ Santa Teresa Mining is developing the Socorro mine, a gold-silver property, at Suaqui Grande, Sonora, and is running at full time its 20-ton mill, which is supplied by its La Colorado unit.

British Mining Circles Anticipate Increased Demand for Metals

Prospecting and Developing New Precious and Base-Metal Deposits Is Expected to Continue in Africa During 1936—Commission Completes Investigation and Reports on Rhodesian Mine Strike

London Correspondent

OPINION IN BRITISH mining circles is that currencies will eventually be stabilized on the basis of the prevailing, or possibly a little higher, price for gold, and that the base metals will enjoy a steadily increasing consumptive demand in 1936. In consequence of this opinion, prospecting for new ore deposits, the reinvestigation of abandoned mines, and additions to the reduction plants of producers will continue, and funds will be forthcoming for the development and equipment of properties good enough to command the approval of reputable engineers.

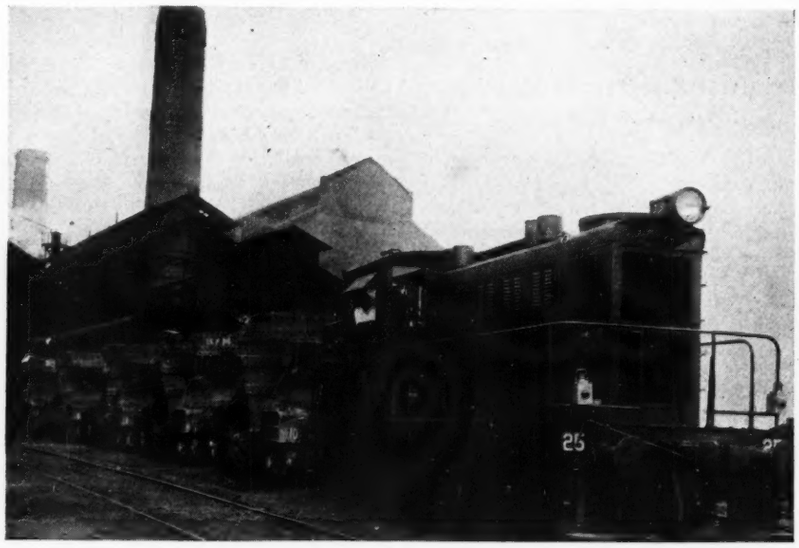
✦ The Union of South Africa has set up a Base-Metal Development Committee to take stock of occurrences within the Union of such minerals as its name implies, and to study the markets for the metals. This committee is reported to be making rapid progress, the Geological Survey Department having been almost doubled. It is expected that the committee will be given executive powers and made permanent, with a complete staff of its own.

✦ Further evidence of the existence of payable gold values in the Far West Witwatersrand is provided by Western Reefs Exploration & Development Company, which has cut, between depths of 2,315 and 2,531 ft., what appear to be seven reefs, ranging from 10 in. to 14 ft. 2 in. in width and assaying from 2.61 dwt. to 8.30 dwt. per ton. The upper two of these reefs average, including 48 in. of quartzite between them, 4.16 dwt. over a width of 170 in. This exposure is in a drill hole put down at a point almost due south from Klerksdorp Township. It is thus in the far-western part of the Far West Witwatersrand.

✦ Hope and belief are entertained that the South African Government will soon give the gold-mining companies some measure of tax relief. The character and severity of the taxation, said to be taking approximately 40 per cent of the total profits of the industry, are being criticized generally. At the Johannesburg Consolidated meeting, Dr. J. G. Lawn declared that the taxation had reached a level unheard of for a primary industry. He suggested that the profits from working very low-grade ores should either be made free of tax or at most taxed at a low rate. He estimated that the rise in the price of gold had made it possibly profitable to work hundreds of millions of tons of marginal ore, a large proportion of which could be made available only by further considerable investments of capital. If taxation were so adjusted as to make the possibility of working such ore a practical reality, the industry would expand enormously, to the benefit of all other South African industries. Other leaders of the South African gold-mining industry are understood to be associating themselves with Dr. Lawn's recommendation. In actual operation, of course, the practicability of the plan would depend on the treatment of the high- and low-grade ores separately. The possibilities are so tremendous, involving perhaps the total ore tonnage treated being doubled, that a way to carry the idea into effect probably will be found.

✦ The gold discovery in Northern Rhodesia being explored by Rhodesia Minerals Concession, and known as Chakwenga, has reached an interesting stage. A crosscut has given assays of 196.3 dwt. per ton over 3 ft. On the hanging wall of this come 2 ft. assaying 10 dwt. and then a further 6 ft. assaying 4.80 dwt., making altogether an average of 58 dwt. over a true width of 11 ft. "Undue importance must not be given to these results," the cable states, "as surface enrichment is involved." The orebody is exposed in trenches over a length of 85 ft., where it contains 8.70 dwt. per ton over a width of 12 ft. In an adit a band of mineralized schist has been cut which assays 140 dwt. across 1 ft., and another crosscut 20 ft. distant from this found the same band carrying even higher values. Exploration of the discovery is being carried forward as rapidly as the facilities at hand will permit.

✦ The commission which was appointed to inquire into the disturbances which occurred at the Northern Rhodesia copper mines last May has reported. It finds that the "Watch Tower Movement" among the natives was an important predisposing cause of the trouble, but the immediate cause appears to have been the "sudden bawling out by the mine police" that the tax was increased all round to 15s. per native. "The amount of damage done," the report states, "was very slight. The fact that such serious strikes could take place without loss of life or destruction of property points to the fact that the relations between Europeans and natives were of a very friendly nature." It says further: "It appears to the Commission that in these trying events the conduct of officials and civilians alike was admirable." The "Watch Tower



MODERN HOT-METAL TRANSPORTATION IN INDIA. A 60-ton 300-hp. diesel electric locomotive built by General Electric in collaboration with Ingersoll-Rand, drawing a train of ladles at the Tata Iron & Steel Works, Jamshedpur, India. Each ladle has a capacity of 60 tons, is equipped with Kling trunnions on S.K.F. roller bearings, and fitted with Willison automatic couplers that act also as buffers

Movement" is apparently a revivalist crusade which teaches of a second coming of Christ, and is exciting great numbers of the natives. It is sharply criticised in the Commission's report.

✦ The profit earned by Mufulira Copper Mines, Ltd., during the quarter ended Sept. 30, after all expenses, debenture interest, and depreciation, is officially estimated to have been £28,000, subject only to taxation. This result was achieved with production limited by the quota to 2,331 long tons of copper per month, so the proportion of costs made up of debenture interest and overhead was abnormally large.

✦ It may interest some of those engaged in mining to know that between 350 and 400 tons of columbite, which the Jantar Nigeria Company, Ltd., had accumulated over several years because of there being no market for it, has recently been sold for shipment to the United States.

✦ The October gold production of the Union of South Africa was 931,305 oz., worth at the price prevailing £6,565,596, and the silver production was 87,602 oz. Working profit was £2,781,014.

✦ In addition to 1,635 long tons of zinc, Rhodesia Broken Hill Development Company produced 110 tons of vanadium concentrates and 17 tons of fused vanadium in November. The company now has a market for all of its vanadium output.

✦ Trepca Mines, Ltd., in November recovered 5,133 metric tons of 79.32 per cent lead concentrates assaying 24.1 oz. of silver per ton, and 8,104 tons of 49.67 per cent zinc concentrates, 50,274 metric tons of ore being milled.

✦ John A. Agnew criticized the South African tax laws at the meeting of Consolidated Gold Fields. He said the formula was so designed that in certain cases it may pay to mine and mill waste rock. Ability to reduce grade is not common to all mines, and those which cannot have to suffer for those that can, shortages from one mine having to be made up by increased payments from others. He said experiments convinced the management that flotation of the sand product before cyanidation would give Simmer & Jack an additional profit of £2,130 a month, the capital cost of needed plant being £14,700. But on the basis of the 1935 excess-duty proposals, not less than £1,600 per month, or 75 per cent of such profit, would have gone to the government. It was decided not to install the plant. He said the proportion taken by the government was in fact in certain cases far more than 50 per cent of the excess profits, and to replace the excess profits and surtax he recommended a straight tax at a flat rate on all profits. A straight tax would permit reasonable certainty in the calculation of prospective profits.

Mount Isa, in Australia, Commences Production of Zinc Concentrates

Addition to Mill and Development of Sulphide Ores Containing Zinc Will Increase Company's Operations—Lead and Zinc Mines at Rosebery in Tasmania to Be Reopened—Bucket Dredges for Placer Mining in New South Wales

MOUNT ISA has just commenced the production of zinc concentrate and will make regular shipments overseas, the annual output being about 90,000 tons. The sulphide ore at Mount Isa contains about 9 per cent zinc. At present Mount Isa is milling only 11,000 tons weekly, and this is to be increased to the former figure of 17,000 tons weekly.

✦ Plans are in hand for working the rich lead-zinc mines at Rosebery, Tasmania, which are owned by the Electrolytic Zinc Company of Australasia, Ltd. A mill with a capacity of 3,500 tons weekly was completed about five years ago, but it has never operated. There are two mines: The Hercules, at Mount Read, consists of a number of wide, lenticular bodies in schist, and the Rosebery, at Rosebery, 5 miles north of Mount Read, is a continuous lode with an average width of 14 ft., and is also in schist. This lode has been proved over a distance of 2,500 ft. At both Hercules and Rosebery adits will make for cheap mining. The ore from Hercules will be transported to Rosebery over an aërial ropeway and will be mixed with Rosebery ore to give a feed assaying about 25 per cent zinc, 6 per cent lead, 6 oz. silver per ton, and 2½ dwt. gold. The lead concentrate will be shipped to Port Pirie and the zinc concentrate, after roasting at Zeehan, will be shipped to the company's works situated at Risdon, Tasmania.

✦ At the Emperor mine, in Fiji, the existing pilot cyanidation plant is to be extended to handle 2,000 tons monthly, assaying 12 dwt. The ore in the upper part of the lode is soft and clayey and not easily filtered. This limits capacity. Development of a level below the adit level is in hand, and if results are satisfactory a plant to treat 20,000 tons monthly is to be erected. On the Loloma lease a crosscut 40 ft. wide assayed 3 oz. 4 dwt. per ton. This ore contains telluride, a fact that may complicate the flowsheet, to determine which experimental work is now being done.

✦ There is no report of the reopening of the Lake George mine, at Captains Flat, N.S.W., which contains 3,000,000 tons assaying 12.9 per cent zinc, 7.5 per cent lead and 2.4 oz. silver per ton. Experimental work in a large pilot plant has shown that this ore can be treated by flotation to produce three separate high-grade concentrates—lead, zinc, and iron. The mine is owned by a London company, the Lake George Metal Corportation.

✦ The higher prices for lead and zinc are of great benefit to the base-metal industry in Australia, which, since the intense activity in gold mining began several years ago, has been depressed. At Broken Hill increased profits are being earned, and the reopening of the Broken Hill Proprietary's mine, which has been idle since 1930, is under discussion.

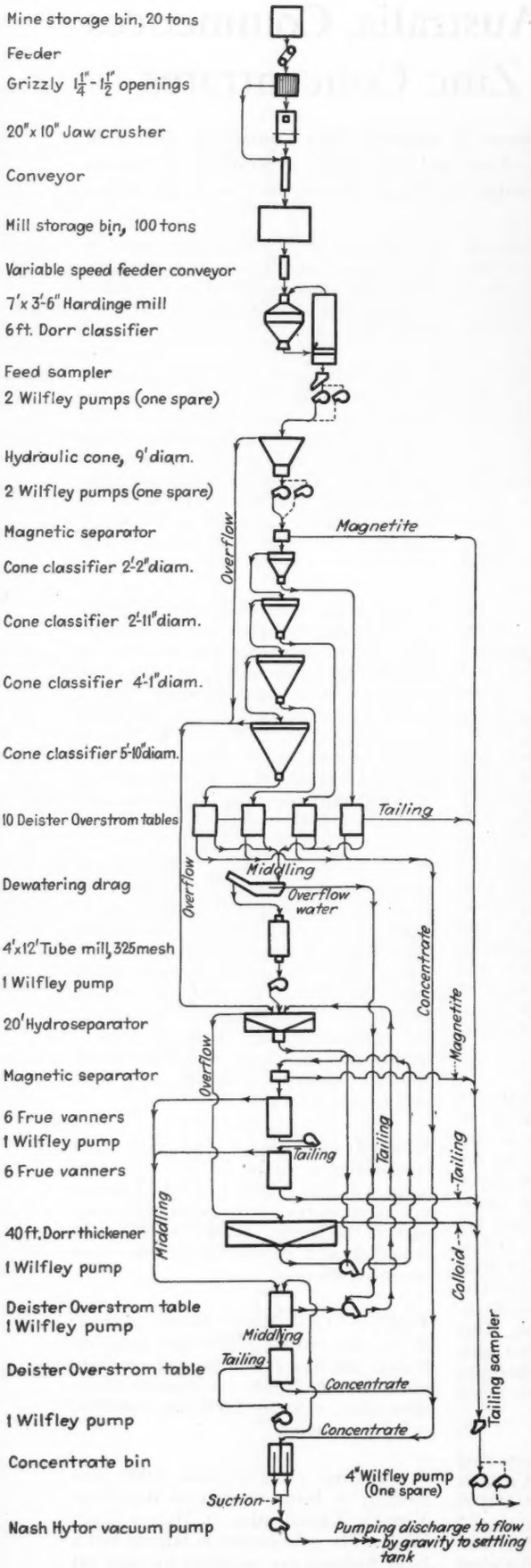
✦ Yellowdine Gold Development, which is developing the rich find at Yellowdine, W.A., estimates ore reserves at 135,000 tons assaying 1½ oz. fine gold per ton. A crosscut between Nos. 2 and 3 shafts proved a lode width of 57 ft. assaying 2 oz. 12 dwt. The mine is being equipped with a twenty-head battery and cyanide plant with a capacity of 5,000 tons monthly. The estimated profit is £51,000 monthly.

✦ Aberfoyle Tin, N.L., operating on the northwest coast of Tasmania, is to drive an adit 8 x 6 ft. a distance of 3,000 ft., to cut existing tin-wolfram lodes 200 ft. below the bottom (No. 2) level. For the twelve months ended June 30, 1935, the company treated 13,218 tons for 280 tons of high-grade tin concentrate, 337 tons of second-quality tin concentrate, and 26.3 tons of wolfram, assaying 72.2 per cent WO_3 and 0.4 per cent tin.

✦ New Zealand gold production for 1934 is officially given as 160,248 oz., compared with 161,755 oz. in 1933. There is a pronounced revival of dredging in many parts of the Dominion, and the 1935 yield should show a substantial increase over recent production.

✦ Hill 50 Gold Mines, Mount Magnet, W.A., has proved 33,000 tons assaying 8 dwt. and has 24,000 tons of probable ore assaying 7 dwt. A cyanide treatment plant, capacity 2,000 tons monthly, is being installed.

✦ A milling plant to treat 5,000 tons monthly is being erected on the Great Victoria United mine at Marvel Loch, W.A. The gold occurs in laterite and a large tonnage can be mined by open cut methods.



FLOWSHEET of mill at Pinyok Tin mine

Mill at Pinyok mine of Siamese Tin Mines, Ltd.

A New Tin Producer in Siam

WHILE most others have been worrying (it now seems unnecessarily) about the future price of tin, a group of mining capitalists, chiefly British and American, have purchased extensive tin properties in Siam and have developed a mine and equipped it to the stage of production. The financing has all been done privately, with no public offering of shares.

Five or six years ago British American Mines, Ltd. (Capt. Walter Broadbridge, Preston K. Horner, and associates), secured an option on a granite-limestone contact deposit of tin ore in southern Siam. Exploration soon proved the existence of a large tonnage of 3 per cent ore. The property was purchased and others in the same district were acquired.

Siamese Tin Mines, Ltd., was organized to take over, develop, and equip the property. This company has sold £100,000 of debentures, out of £300,000 authorized, but its share capital is wholly owned by British American Tin Mines, Ltd., the chief interests in which are the International Mining Corporation and the Pardners Mining Corporation, of New York, and Anglo French Exploration, various companies of the Tronoh Company group, and British American Mines, in London.

The Pinyok mine—this being the name of the contact deposit already mentioned—is estimated to have 1,500,000 tons of 3 per cent tin ore developed, with a further 500,000 to 1,000,000 tons of like grade probable. Several independent engineers have examined it and are in agreement as to this tonnage and grade. These figures dwarf most of the world's other tin mines. The deposit, which is reported to be about 1,200 ft. long by 400 ft. wide, will be mined by open-cut methods.

As Siam is a participating government in the tin-restriction scheme, the output of Siamese Tin Mines, Ltd., will be limited for the present by such quota rights as it may be able to arrange. Various quota rights have been secured by purchases of controlling interests of properties less favorably situated than the Pinyok mine, and negotiations for a quota for Pinyok are proceeding.

The mill, a halftone cut of which is presented above, was designed by A. G. McGregor. It began operating early in November of 1935. The flowsheet is the combined work of the company's metallurgist, R. S. Handy, and Holloway & Company, of London. The production of this plant is expected to be between 1,000 and 2,000 tons of tin concentrates annually, depending on the grade of ore treated.

This mill is understood to have been erected for temporary use only, not as a first section or unit, but to put the enterprise in production while awaiting an increase of quotas and while a much larger permanent plant is being designed and built.

After four years of laboratory and pilot-plant work in London, a process has been developed by which tin minerals are reduced to stannous chloride and metallic tin recovered from this by electrolysis. Of the pilot-plant tests the company's recent report says:

"The work has been examined and reported upon by several eminent metallurgists. Your directors are satisfied that the time has come to design the first unit of the plant to be erected in Siam. The designing work is now in progress."

It is the intention to extend the plant now being designed, as the world demand for tin warrants, till its production capacity is raised to 5,000 tons of metallic tin annually. The very large tonnage of high-grade tin ore in reserve naturally calls for such a volume of output.

PERSONAL ITEMS

James Hopkins, of Oroville, Calif., is in the Philippines on professional business.

H. Wells has assumed the management of Mkaradzi mine, of Darwin, South Africa.

Burr Wheeler, general manager of Chile Exploration Company, is in New York from Chuquicamata.

Archie M. Bell, formerly of Tombstone, is now engineer at the Ajax Mine, Arivaca, Ariz.

Merrill Rosengren, Colorado School of Mines, 1935, is resident engineer for Vanderbilt Gold at Kingman, Ariz.

Hand jigs and buddles at Perfeccionada wolfram placer, Bolivia, March, 1935

John M. Carter has accepted the post of mill superintendent of Omega Gold Mines, Ltd., at Larder Lake, Ontario.

R. C. Peyton has been appointed under secretary to the Department of Mines and Works of Southern Rhodesia.

Ralph Baverstock has been elected president and **Dr. John Herman** vice-president of the Mining Association of the Southwest.

Basil Prescott has been retained by Base Metals Mining Corporation to direct the further search for ore in its mine at Field, B. C.

H. DeWitt Smith, of New York, has been elected to the board of Cusi Mexicana Mining Company, to represent Newmont Mining Corporation.

F. O. Bacon is now connected with the engineering department of the Angangueo unit of the American Smelting & Refining Company.

Ralph Merritt, long associated with mining operations in Inyo County, Calif., has purchased the tungsten mine on Pine Creek, near Independence, Calif.

H. W. Kaanta, president of the Willis Gulch Mining Company, has started operations of a new 50-ton mill at the Anchor Mine, Idaho Springs, Colo.

James B. Chamberlain has left his post with the Fairbanks Exploration Company, at Fairbanks, Alaska, and is spending a vacation at Los Angeles.

Arthur C. Brinker has just returned to New York from Bolivia, making the trip in four days in place of the usual four and a half days, as the new Douglas planes from Guayaquil south have shortened the previous schedule. Mr. Brinker has courteously made available to *Engineering and Mining Journal* some interesting views of the wolfram placers herewith shown. These placers are on the east and west sides of the Ayopaya River, extending to a height of over 1,000 ft. above the river bed and varying from a few feet at the top to more than 200 ft. in thickness, measured perpendicularly to the mountain sides near the river. The wolfram vein deposits occur, generally, below the horizon of the tin deposits, which are at an elevation of 10,000 ft. above sea level. The area has undergone excessive erosion, and is of precipitous and rugged topography.

Darwin T. Mason has left Cripple Creek, Colo., and gone to Tucson, Ariz., to spend the winter and spring. He will return to Cripple Creek by June 1 of 1936.

O. L. Gray and his son **O. L. Gray, Jr.,** dredge operators, have left San Francisco for the Gold Coast, West Africa, to join the staff of Tano Gold Dredging, Ltd.

J. H. Stovel has been made vice-president and general manager of Dome Mines, Ltd., in succession to the late vice-president and general manager, H. P. De Pencier.

Albert I. Long, until recently superintendent for Portland Mines, at Kingman, Ariz., is now at Ajo, following sale of the property to the Gold Standard Mines Corporation.

John V. N. Dorr returned to New York late in December, completing a four-months' trip in the course of which he visited England, France, Holland, Rhodesia, and the Transvaal.

K. G. Schwegler, president and general manager of Sierra Gold, Milton Gold, and Jenny Lind Gold Dredging, has moved his office to Room 514, 405 Montgomery St., San Francisco.

Dr. Reginald Aldworth Daly, Sturgis-Hooper professor in the department of geology at Harvard University, was recently awarded the Penrose Medal of the Geological Society of America.

Charles L. Knaus has given up his private practice as mining engineer and surveyor and returned to his former position as designing engineer with the new Mexican Highway Department.

E. E. Barker, consulting engineer, formerly manager of Mufulira Copper, Northern Rhodesia, and until recently in Nevada City, Calif., has opened an office at 200 Bush St., San Francisco.

Angus Campbell is manager and **John Beattie** superintendent of the Omega mine, at Larder Lake, Ontario, at which property the 500-ton mill is to be in operation early in the new year.

Guy H. Ruggles, superintendent of concentration for Inspiration Consolidated Copper, is on leave of absence to engage in consulting work for Mountain City Copper at the property in Nevada.

Taminani wolfram placer, in Bolivia, October, 1935

D. G. Malherbe was recently appointed Assistant Head of the Mines Department of Orange Free State, Mining Commissioner of the State's mining district, and Inspector of Mines for Bloemfontein.

Clayton Robbins has left Cornucopia, Ore., where he was mill superintendent for Cornucopia Gold Mines, to accept a position as mill superintendent for the Balm Creek Gold Mining Company, at Keating, Ore.

Ellis P. Frink has left Los Angeles for Bolivia to accept a position as metallurgist for the Compania Argentifera Laurani de Bolivia. He will be in charge of the company's copper-silver-gold all-flotation mill at Viscachani.

Earle W. McMullen became director of research of the Eagle-Picher Lead Company on Dec. 1. This position formerly was held by **Dr. John A. Schaeffer,** who resigned to become president of Franklin and Marshall College.

Clifton W. Livingston recently accepted a position as mining engineer with the Arizona Comstock Corporation, at Virginia City, Nev., following his resignation from a similar position with the Alaska Juneau Gold Mining Company, at Juneau, Alaska.

E. B. Bronson, president of Bagdad Copper, has been visiting the company's property at Hillside, Ariz. The company resumed work this year after a four-year shutdown. **Charles T. Baroch,** formerly mill superintendent, is now serving as assistant manager.

S. E. Casterton, mining engineer with Phelps Dodge at the Morenci branch for twelve years, has been appointed assistant mining engineer in the United States Bureau of Mines Southwest Experiment Station at Tuscon, Ariz.

John Littlepage, an American mining engineer, has been awarded Lenin's decoration, the highest honor given in the Soviet Union, for his aid in developing the Soviet gold industry. Mr. Littlepage formerly was employed in Alaska. For the last seven years he has been employed in the development of Soviet gold mines.

Dr. Otto Sussman, chairman of the board of American Metal Company, Ltd., has been at Ely and Kimberly, Nev., to inspect properties of the Consolidated Coppermines Corporation, in which American Metals recently acquired an interest. He was accompanied by **A. D. Storke,** managing director of Roan Antelope.

Merle H. Guise, Alaska mining engineer, who has been visiting in New York recently, has returned to his headquarters at Fairbanks, Alaska, where he is to prospect this winter on placer dredging ground. Mr. Guise is a frequent user of airplanes in Alaska in spite of a recent forced landing near Nelson, B. C., during a snowstorm.

Charles A. Banks, of San Francisco and Vancouver, who is managing director of Placer Development, Ltd., left the United States on Dec. 28 for Colombia, where he will spend some time at the Pato and Asnazu operations, in which Placer Development is jointly interested with the Oroville Company of London. Mr. Banks is also managing director of the Bulolo Company.

Charles M. Brinckerhoff, who has been employed as an engineer and mine foreman by Inspiration Consolidated Copper Company for the past nine years, has gone to Potrerillos, Chile, where he has accepted the position of assistant mine superintendent with Andes Copper. Following his graduation from the School of Mines at Columbia University, Mr. Brinckerhoff was employed at the Clifton smelter for two years before going to Inspiration.

F. H. Kihlsted, mining engineer from Sweden, has gone to the Philippines to undertake a geological and mining survey of the property of the Philippine Iron Mines, in Camarines Norte, the only large iron mine in the country. He has had considerable experience in Africa, Europe, and the United States. Future activities of the company will depend upon his reports, and it is likely that around 300,000 tons of iron ore will be exported this year from the company's mines, all of it going to Japan.

OBITUARY

W. A. O'Flynn, manager of the O'Brien mine, at Cobalt, since 1929, died in Toronto on Nov. 19.

Maurice Warder Bacon, mining engineer, president of Montizona Copper Company, Pima County, Ariz., died in New York on Jan. 4; aged 65.

Robert Huntingdon Lyman, pioneer Cobalt mining man, died at Cobalt on Nov. 30, at the age of 69.

Gideon S. Harkness, long identified with mining developments in Ontario, died on Dec. 8 at Toronto.

Millard M. Cowden, assistant chief engineer for Nevada Consolidated at the Ray, Arizona, branch, died on Dec. 6.

George Beet, pioneer in the African diamond fields, journalist, and author, died recently at Kimberley; aged 83.

Robert N. Bell, formerly for a period of sixteen years inspector of Mines for Idaho, died on Dec. 1 at Boise; aged 71.

Herbert Hamlin, Sr., veteran mine operator in Nevada, Oregon, Washington, and other mining states, died recently in Reno, Nev.

Oscar Lachmund, a retired mining engineer, who had been living at San Pedro, Calif., for the past fourteen years, died recently in that city at the age of 69.

Edward Halse, an English mining engineer, who had from 1877 to 1913 been associated with mining enterprises in many parts of the world, died in England recently at the age of 81.

H. V. Wallace died recently at Kirkland Lake, Ontario, where he had resided for six years as chief metallurgist of Wright-Hargreaves Gold Mines. A graduate of the Royal School of Mines, London, Mr. Wallace had a long experience in Mexico and the United States before coming to Canada.

LETTERS

"Essential Criteria in Examining Gold-Quartz Mines"

The Editor:

Commenting on "Essential Criteria in Examining Gold-Quartz Mines," by John Carter Anderson, consulting engineer, in *E.&M.J.*, of September, 1935, if I interpret the author of this interesting article correctly, "danger signals" of gold-quartz "ore-bodies" in the North American Cordilleran region petering out are:

1. Persistent increase in the baser metals. This may be gradual or abrupt.
2. Marked decrease in fineness of the gold. This indicates an approach to the bottom of the ore zone.
3. Presence of a dike (the most acid dike in the particular igneous assemblage of rocks in the district) *from which the gold-quartz segregated.* The dike can often be recognized by the presence of finely disseminated *primary* pyrite!
4. Association of pegmatite or feldspar with the gold-quartz veins. Association appears to mean transition from pegmatite or feldspar to gold quartz or the occurrence of gold quartz near pegmatite or feldspar, particularly above pegmatite or feldspar.

Mr. Anderson's experience that persistent increase in the baser metals, and a marked decrease in fineness of the gold, indicate an approach to the bottom of the gold zone of gold-quartz veins, does not appear to be specifically illustrated in the occurrences he describes. Examples in which the quantitative changes in metallic minerals, gold tenor, and gold fineness are carefully traced would be of much interest. His main thesis is that gold-quartz veins differentiate *directly* from the most acid dikes of any igneous assemblage. Hence, when the quartz veins pass into the dikes they have reached their source and must end. The dike-source of the quartz may not be exposed, but it is believed by Mr. Anderson that it always exists and that every quartz vein has a direct connection with an igneous mass.

The examples given by Mr. Anderson seem to show that the gold-quartz veins peter out above, or in, underlying acid dikes. There appear to be changes downward from gold-quartz veins to pegmatite and then to acid dikes. However, one wonders if it is clear that the gold-quartz veins (not merely the quartz of the pegmatite or barren quartz physically continuous with the pegmatite) were segregated *directly* from the acid dikes. If not, the gold-quartz veins near or in the dikes, though bottomed, are not necessarily at their genetic source. Many quartz veins terminate downward without being at their genetic source. This may be shown by the extension downward of adjoining quartz veins for hundreds or thousands of feet or/and the absence of any possible intrusive rock source near the veins that have terminated downward.

In some occurrences, gold-quartz ore continues downward in, along, or near the most felsic dikes in the country, such as dikes of alaskite, albitite, quartz porphyry, and albite porphyry, so the gold quartz cannot be at a genetic source in the upper parts of the dikes. Gold-quartz veins sometimes end above or in mafic dikes such as diabase, gabbro, or lamprophyre dikes, just as they may end above or in felsic dikes, and it may be just as plausible to ascribe their origin to segregation from the mafic dikes as from the felsic dikes. In many instances it is evident that these mafic or felsic dikes were intruded prior to, or subsequent to, the gold-quartz veins; that is, the gold-quartz veins did not segregate directly from the particular part of the

dike in which, or against which, the veins lie. The common evidence for this is the penetration of quartz veins along fissures in or along the dike, the partial replacement and alteration of the dike in or along the quartz veins, or the interruption or cutting off of the vein by post-vein intrusion. Only in those cases (if such exist) in which there is evidence that the gold-quartz veins actually have segregated from an underlying dike can one validly maintain they have reached their genetic source. Though the vein terminates downward it may be much removed from its genetic source. Diversion, dispersion, interruption, or cessation of depositing fluids may cause vein termination. Physical conditions, including blocking of the fissured zone by a comparatively unfissured dike, or change in strength and continuity of fissuring where it encounters a dike, may explain termination downward of a gold-quartz orebody. It is difficult to be sure from Mr. Anderson's descriptions that genetic source, rather than physical or physicochemical conditions, cause downward termination of the gold-quartz veins with which he deals in his discussion.

Clear-cut examples of direct segregation of gold-quartz veins from dikes would be of outstanding economic and scientific importance. Students of the subject would be grateful to Mr. Anderson if he would go to the trouble to picture and describe his observations in convincing detail. My own observations and understanding lead to the inference, in numerous instances, that space, time, and genetic association of dikes and gold-quartz veins result, among other factors, from differentiation of both veins and dikes from the same general magmatic source, not because of direct segregation of the veins from the associated dikes.

Where quartz veins are specially associated with pegmatite it appears that they are usually of no economic value as a source of gold. It is conceivable, and probably a fact, that under physicochemical conditions favorable for emplacement of pegmatite, gold quartz is not deposited at the same time in quantities sufficient to produce an important gold orebody. Nevertheless, there remains the possibility that the pegmatite dike, or the rocks near it, may be invaded by gold-depositing fluids which produce a gold orebody subsequent to the emplacement of the pegmatite dike. A prominent example of this appears to be the Passagem lode, in Brazil (see Lindgren's "Mineral Deposits"). With this reservation Mr. Anderson's premise that association of gold-quartz veins with pegmatite is a "danger sign" will probably be acceptable to many observers.

E. Y. Dougherty.

Toronto, Ontario

Nickel and the United States

The Editor:

I have read with much interest the contribution of G. W. Pawel in your issue of September, 1935, concerning nickel and the disparity between its consumption and production in the United States.

I have had the somewhat unusual experience of working in both the Sudbury nickel mines and those of New Caledonia (although many years ago), and have always been much interested in nickel and at various times investigated, sometimes purely from curiosity, a number of American nickel deposits. Therefore, I venture to make a few comments in respect to Mr. Pawel's suggestion that attempts should be made to revive the domestic nickel industry, which would certainly be a most desirable accomplishment from a purely industrial standpoint as well as from the standpoint of national defense.

For the past thirty years it has appeared that the operation of a successful nickel mine in the United States would be a vastly profitable undertaking and one which would receive approval and perhaps even cooperation from the Federal Government.

As to the old mines, such as those in Connecticut and Pennsylvania, it may be assumed that their best ores were practically worked out before they were closed down, and it is probable that the ore which they could produce in future would be of extremely low grade, so that they could not hope to compete on anything like even terms with the Sudbury ores or those from New Caledonia, which last, as a matter of fact, could not compete with Sudbury if no special reasons existed for keeping the New Caledonia mines in operation.

Our nickel prospects, for example in North Carolina, Oregon, Nevada, Arizona, California, Montana, and elsewhere, have been investigated many times and have never measured up to the desired standard, since they either appear to promise only a very limited tonnage or an average grade of less than 2 per cent nickel or 2 per cent combined nickel and copper. I have never seen the deposits in Alaska, and their recent development, as indicated by Mr. Pawel, may be very encouraging, but I believe that up until a few years ago they did not seem likely to be serious competitors with the producing foreign mines.

The average grade of the ore from the Creighton mine, which for many years yielded the principal output of the Sudbury district, was nearly 5 per cent nickel with 1.5 per cent copper, and though the Frood mine ore is substantially lower in nickel, the copper content is higher, and, moreover, the value of the platinum metals is very considerable. The average grade of the ore mined in New Caledonia is over 6 per cent nickel when the ore is dried, or, say, 5 per cent as it is actually mined with from 15 per cent to 20 per cent of uncombined moisture, and in New Caledonia there are large bodies of ore containing up to 4 per cent nickel (wet) which have never been profitably worked.

As to reduction plants, these are naturally located near producing mines except when local conditions are unfavorable. Until 1901 the Sudbury ores were merely smelted in Canada to a low-grade matte containing some 30 per cent combined nickel and copper, and the subsequent converting and refining were done in the United States. Converting to high-grade matte then followed, and more recently all the procedure necessary to make refined nickel and copper has been carried on in Canada, although a certain amount of matte from the Creighton ore is still sent to West Virginia for the production of Monel metal.

Prior to 1907 New Caledonia nickel ore was sent crude to Europe or the United States, except for one short and unsuccessful attempt to make ferronickel, but local smelters have since been erected and most of the steps in smelting and refining the metal can now be performed on that island.

In both cases it would now be disadvantageous to the producing countries as well as to the operators to carry on these steps elsewhere, and no such reversion to the former practice can be expected unless forced by an excessive tariff, which would naturally increase the price of nickel and hence tend to decrease its use in industry.

Since the developed reserves of pay ore are large in New Caledonia and enormous in the Sudbury district, it is obvious that even with the protection of the present 3c. tariff no competition could be maintained from any properties in the United States unless these should either develop substantial quantities of similar grade material, or unless they could be operated at exceptionally low cost, so that, as in the case of porphyry coppers, the cost of producing metal would compare favorably with that from the higher-grade mines; but nickel (unless perhaps in Alaska) does not occur under conditions which seem to make this last alternative possible.

None the less, any domestic nickel production would have some very material advantages over all foreign competitors and should be successful, provided, but only provided, that it were based upon a really good ore deposit located in the United States; and so it appears to me that before we can hope to establish such a self-supporting nickel industry, a large amount of money must be spent in exploration and development of ore deposits, with a very substantial capital available for smelter and refinery, and although some of the showings appear reasonably promising, it is evident that these have not as yet seemed sufficiently attractive to private capital to offset the risk involved in making this attempt.

Under existing conditions, when such enormous sums of Government money are being spent primarily for the employment of labor, it would appear that the Federal Government might wisely turn its attention to such exploration for nickel and other essential metals, which, even if unsuccessful, would employ a large number of men and tend to open up some rather remote sections of the country, and, if successful, would also have the double advantage of creating new industries for the future and of making good our needs for metals of which the country is now deficient, and in that group nickel is assuredly one of the most outstanding.

G. M. Colvocoresses.

Phoenix, Ariz.

PUBLICATIONS RECEIVED

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Physiography (Geomorphology) of Western Australia. By J. T. Jutson. Second Edition. Bulletin 95, Geological Survey, Perth, Western Australia. Pp. 366. Five supplemental maps.

Transvaal Chamber of Mines Forty-fifth Annual Report, 1934. Johannesburg, South Africa. Pp. 191.

Mining Laws of Mexico—Tax Laws and Decrees (English translation). Published by the Mexican Mineral Survey, Room 419, Mexico, D. F., Mexico. Cloth, 5x7 in. Pp. 184. Price $10, United States currency, by International Money Order.

Lake Superior Iron Ores. Directory of Mine Operators and Statistical Data. July, 1935. Lake Superior Iron Ore Association, Cleveland, Ohio. Pp. 32.

Preliminary Report on Geology and Ore Deposits of the Eastern Part of the Yellow Pine District, Idaho. By L. W. Currier. Pamphlet 43. Idaho Bureau of Mines and Geology, Moscow, Idaho. Pp. 27.

Application of the Diesel Engine to Small Mines. By W. W. Staley, Idaho Bureau of Mines and Geology, Moscow, Idaho. Pp. 30. Price 25c.

The Eastern Lupa Goldfield. Bulletin No. 8. By E. O. Teale, assisted by N. W. Eades. Accompanied by petrological notes by F. Oates. Geological Survey Department, Dar es Salaam, Tanganyika Territory, Africa. Pp. 61. Price 5s.

The Future of Metal Mining in the United States. By G. W. Danehy. Published by the author, 206 Patterson Bldg., Denver, Colo. Pp. 40. Price 35c.

Untersuchungen über die Wirkung des Xanthogenates auf Bleiglanz. By Walter D. Wilkinson. Published by Konrad Triltsch, Würzburg, Germany. Pp. 61.

Les Resources Minerales de la France d'outre-Mer. Part III, dealing with zinc, lead, silver, copper, gold, radioactive minerals, mica, and precious stones. Also a section dealing with phosphate. Published by the Bureau d'Etudes Geologiques et Minières Coloniales, Paris. Pp. 394 and 207 respectively.

The Gold Hill Mining District, Utah. By T. B. Nolan. Professional Paper 177. U. S. Geological Survey. For sale by Superintendent of Documents, Washington, D. C. Pp. 172. Price $1.25.

A Study of Clay Winning and Its Costs in the Provinces of Ontario and Quebec. By J. F. McMahon. Bulletin 754. Department of Mines, Ottawa, Ont. Pp. 90. Price 25c.

Review of Literature on Effects of Breathing Dusts, With Special Reference to Silicosis. Part II-B. Chapter 4. Prevention of Dust Diseases (Sections 3-5). By D. Harrington and Sara J. Davenport. U. S. Bureau of Mines Information Circular 6848. Pp. 119-210.

Colorado—Annual Report of the State Bureau of Mines for 1934. By John T. Joyce, Commissioner of Mines, Denver. Pp. 72.

Geology of the Makaha Gold Belt, Mtoko District. By A. M. Macgregor. Bulletin No. 28. Geological Survey, Salisbury, Southern Rhodesia. Pp. 47. Price 1s, 9d. (Postage abroad, 1d.)

Study of the Mineral Composition of Mine Dust. By T. L. Walker. Also, "An X-Ray Diffraction Methods for the Estimation of Quartz in a Mixture of Silicate Ores." By George L. Clark and Dexter H. Reynolds. These two papers are included in Contributions to Canadian Mineralogy, 1935, published by the Department of Mineralogy, University of Toronto, Toronto, Ont.

Diesel Engine Potentialities and Possibilities in Rail Transportation. A. I. Lipetz, Engineering Bulletin Purdue University, Vol. XIX, March, 1935. No. 2. Pp. 47.

Molybdenum Steels. Their Manufacture and Application. By Julius L. F. Vogel and W. F. Rowden, of High Speed Steel Alloys, Ltd., Widnes, England. A well-illustrated 103-page book describing the progress made in the application of molybdenum to a wide range of alloy steels and their varions industrial uses. Price 5s.

Lefroy and Back Creek Goldfields. By E. Broadhurst. Geological Survey Bulletin 32, Department of Mines, Hobart, Tasmania. Pp. 87, plus 12 separate maps and sections. Price, 2s. 6d. Also Bulletin 43, on the **Mathinna and Tower Hill Goldfields,** by K. J. Finucane, with an Appendix by P. B. Nye. Pp. 132, plus maps and sections. Price, 2s. 6d.

Mining Methods and Costs at Eureka Standard Mine. By E. D. Gardner. Information Circular 6851, U. S. Bureau of Mines, Washington, D. C. Pp. 14.

Mining and Milling Tungsten Ores. By W. O. Vanderburg. Information Circular 6852, U. S. Bureau of Mines, Washington, D. C. Pp. 47.

Detailed Statistical Microscopic Analyses of Ore and Mill Products of Utah Copper Company. By R. E. Head, A. L. Crawford, F. E. Thackwell, anu Glenn Burgener. Report of Investigations, No. 3288, U. S. Bureau of Mines, Washington, D. C. Pp. 93.

Transactions of the Institution of Mining and Metallurgy, Vol. XLIII, 1934. Pp. 788. Technical Book Shop, Salisbury House, London, E.C. 2, England.

Travertine Deposits Near Port St. Johns. By W. Kupferburger. Bulletin 4, Geological Series. Department of Mines, Pretoria, South Africa. Pp. 15. Price 6d.

Application of the Diesel Engine to Small Mines. By W. W. Staley. Pamphlet 42, Idaho Bureau of Mines and Geology, Moscow, Idaho. Pp. 30.

Guide to Applicants for Direct Loans. Prepared by National Conference of Business Paper Editors and Associated Business Papers, Inc., 330 West 42d St., New York, N. Y. Pp. 32. Price 25c. Describes three sources of governmental aid to industry: Reconstruction Finance Corporation, Federal Reserve Banks, and Federal Housing Administration.

Microscopic Investigation of Friedensville, Pennsylvania Zinc Ore. The Institute of Research, Lehigh University. Publication No. 11, Circular No. 114, Lehigh University, Bethlehem, Pa. Pp. 10.

The Southern Alaska Range. U. S. Geological Survey Bulletin 862. Pp. 101.

Geology and Ore Deposits of the Casto Quadrangle, Idaho. U. S. Geological Survey Bulletin 854. Pp. 135.

Geology of the Santa Rita Mining Area, New Mexico. U. S. Geological Survey Bulletin 859. Pp. 78.

Cuerpo de Ingenieros de Minas del Peru Bulletin No. 111. La Industria Minera en el Peru, 1932-1933. J. Hohagen, Lima, Peru. Pp. 294.

The Geology of a Portion of the Country East of Steytlerville, Cape Province, Union of South Africa. Department of Mines, Geological Survey. Pretoria. Pp. 44.

Some Fundamentals of Highway Improvement. Ben H. Petty, Extension Series No. 34, Engineering Bulletin Perdue University, Lafayette, Ind. Pp. 43.

Journal of Research of the National Bureau of Standards. United States Department of Commerce, Vol. 15, No. 4, Washington, D. C. Pp. 341-439.

The following publications have been received from the Dominion Geological Survey, Ottawa, Ont.

Lode Gold Deposits of Fairview Camp, Camp McKinney, and Vidette Lake Area, and the Dividend-Lakeview Property Near Osoyoos, B. C. By W. E. Cockfield. Memoir 179. Pp. 38. Price, 25c., with accompanying set of maps.

Southern Saskatchewan, Geology of. By F. J. Fraser, F. H. McLearn, L. S. Russell, P. S. Warren, and R. T. D. Wickenden. Memoir 176. Pp. 137. Price, 50c.

Barkerville Gold Belt, Cariboo District, British Columbia. Memoir 181. By G. Hanson. Pp. 42. Price, 25c.

The Southern Alaska Range. By S. R. Capps. Bulletin 862, U. S. Geological Survey, Washington, D. C. Pp. 101, with maps.

Pre-Cambrian Rocks of the Lake Superior Region, With Revised Geologic Map. Professional Paper 184, U. S. Geological Survey, Washington, D. C. Pp. 34.

El Yeso en Lima. By German D. Cevallos. Bulletin 110 of the Cuerpo de Ingenieros de Minas del Peru, Lima. Pp. 170. Also Bulletin 111, entitled **"La Industria Minera en el Peru, 1932-3."** By J. Hohagen.

Iowa Geological Survey. Annual Reports for 1930 to 1933, inclusive, comprising four papers. Des Moines, Iowa. Pp. 471.

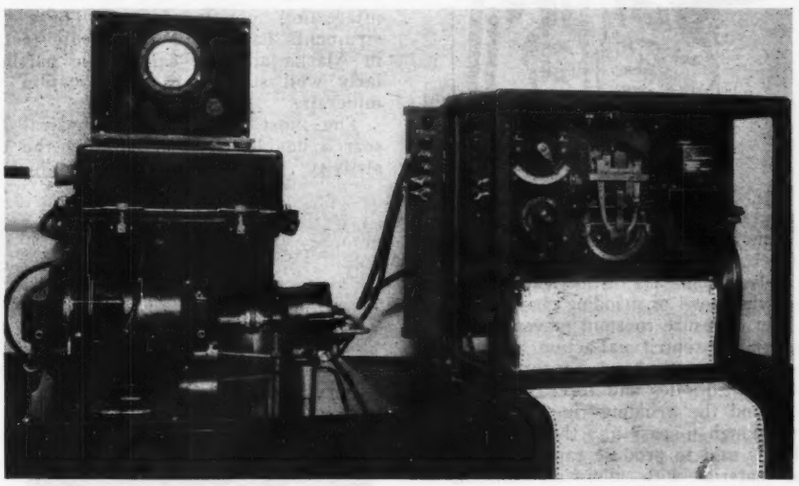
Induction Prospecting for Shallow Ore Deposits and Small Metallic Objects. By J. W. Joyce. Information Circular 6854, U. S. Bureau of Mines, Washington, D. C. Pp. 18.

EQUIPMENT NEWS

Chemical Show Reveals Equipment for Use in Mining and Metallurgy

THE FIFTEENTH EXPOSITION of Chemical Industries, held from Dec. 2 to 7 at the Grand Central Palace, New York, informed the mining man that chemical research, during the dull years of the depression, had found more uses for his metals. Alloys in numerous combinations of base metals, and tantalum in tubes now available in sizes from hypodermic needles up; Monel metal, and its numerous uses; rhodium-platinum gauze, and more uses for lead-lined iron pipes and valves that are in demand in the chemical and allied industries. Nickel, copper, lead, and zinc are base metals used for sheets, tubes, and pipes which may be veneered with precious metals, gold and silver, so as to resist corrosion. New compact safety equipment for use in mines was displayed, together with pumps, valves, pressure and continuous vacuum filters, variable-speed transmissions, pulley units, and devices for measuring and checking the weights of materials.

● Various principles of crushing technique, screening devices, chemical reagents, agitators, thickeners, clarifiers, filters, and dryers were of interest to the metallurgist and millman. Operating principles of this type equipment were unchanged, but simplification and refinement in design were evident. Some of the equipment displayed at the show of interest to the mining industry is herewith described.



Electric Dust Recorder

A new instrument, the electric dust recorder, sold by Mine Safety Appliances Company, Pittsburgh, Pa., is designed for permanent or semi-permanent installation. It is intended that it will be operated continuously to produce a record of the dust concentration present in any atmosphere. The basic principles of operation were developed by Drs. Drinker and Hazard, of Harvard University, School of Public Health.

The instrument consists of two distinctly separate parts, the first being the analyzer unit and the other a Leeds and Northrup recording potentiometer. In installation, these two parts can, of course, be very widely separated so long as they can be interconnected with wires conveying the potential developed in the analyzer unit to the recording potentiometer.

The analyzer unit operates in the following way: Light from a single source is broken by means of two right-angle prisms into two separate beams of equal intensity, which are directed through clear moving picture film on to the active surfaces of photo-electric cells. The film passing through one beam is absolutely clear. After having passed through this beam, the surface of the film is wetted with a solution so that as the film is drawn past a jet of air drawn from the inclosure under test, any dust particles in that air will be deposited on the wet, sticky surface of the film. The film is then drawn through the second beam of light and any dust particles which have been deposited interfere with the beam to prevent all of the light in the second beam from reaching the second photo-electric cell. The photo-electric cells are connected in opposition in a balanced electrical circuit.

When more light reaches one cell than the other, a measurable potential is available for activating the potentiometer circuit, producing there an indication of the concentration of dust present in the atmosphere.

A small motor and pump unit is an integral part of the analyzer mechanism With this pump, it is possible to draw a sample from a distance of 100 ft.

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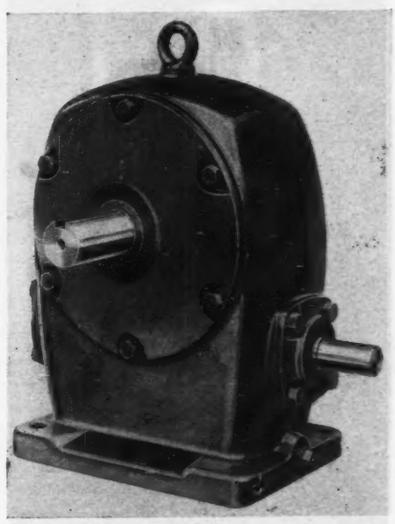
Worm-Gear Reducer

Announcement is made by Link-Belt Company, Philadelphia, that it has developed and is now in production on a new line of cut-tooth worm-gear speed reducers said to be simple, compact, of accessible construction, and offering flexibility of driving arrangement. The new reducers are available in a wide range of ratios and capacities, with single or double reduction, and in horizontal and vertical types. All are provided with precision tapered roller bearings and automatic lubrication within dust-proof gray-iron housings.

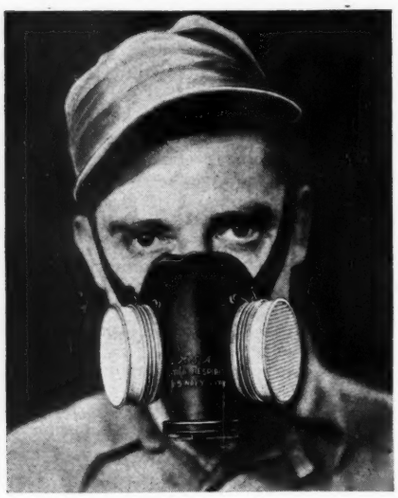
The output shaft, with its chilled phosphor-bronze worm wheel, can be



located above or below the worm shaft, which is made of a low-carbon alloy-steel forging, carburized and heat-treated after the worm threads have been cut thereon. A feature of the double-reduction reducer is the unitized attachment of the primary reduction unit to the side of the final-reduction housing.

Low-Resistance Respirator

Unique in design and construction, the MSA Comfo Paint Respirator features twin side-placed filters doubling the breathing intake area and reducing by one-half the breathing resistance of



previous models. The use of twin filter cartridges is found to increase the chemical life of each cartridge and the decreased air flow results in more efficient removal of paint vapors and gases. The soft, flexible, inturned edge of the face piece is said to assure a comfortable fit and an airtight seal.

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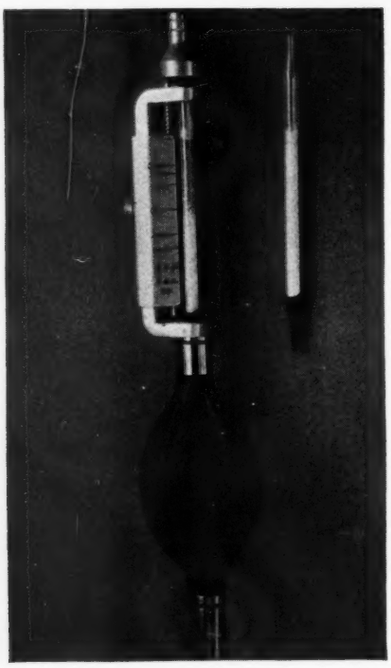
Hydrogen Sulphide Detector

The great toxicity and widespread occurrence of hydrogen sulphide in industry indicate the need of a simple means



of detecting and measuring accurately the hazard at the working place itself, since the apparatus and methods in common laboratory use are, in general, either too cumbersome or too slow for effective use in the field. The instrument announced by Mine Safety Appliances Company, of Pittsburgh, Pa., is said to give an accurate reading in less than a minute, and it is small, light, convenient and simple to carry and will indicate the actual concentration of the gas in amounts ranging from 0 to 0.04 per cent by volume. Although hydrogen sulphide has a marked odor, this does not serve as a warning of danger, since 2 to 15 minutes' exposure to concentrations of hydrogen sulphide as low as 0.01 per cent (one part in ten thousand) produces a paralysis of nerve centers that results in the loss of the sense of smell.

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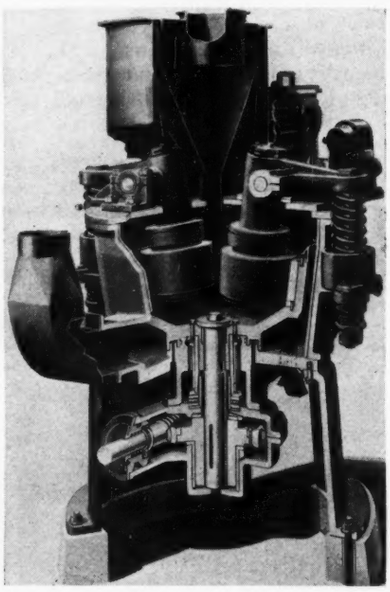
Pulverizing Bowl Mill

A new pulverizing machine said to be built around an entirely new grinding principle is reported by Raymond Bros., 1315-1325 North Branch St., Chicago, Ill. The company reports it will increase production



efficiency and reduce wear, vibration, and noise by eliminating metal-to-metal contact in pulverizing. Its distinctive feature is a revolving bowl or grinding chamber, which is said to insure constant movement of the material by centrifugal action. As soon as the feed enters the bowl, it is thrown against the inclined sides and forced between the rolls and the grinding ring until reduced fine enough to pass into the air separator. This is said to produce rapid reduction of the material with minimum consumption of power and low costs per ton of product.

For long runs at sustained capacity, the company reports unusual economies in pulverizing limestone, gypsum, and other nonmetallic minerals and manufactured products. These bowl mills are available in sizes of from 1 to 20 tons per hour for a fineness range of 10 to 325 mesh.

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Lifting Tool

A development designed to meet requirements of pulling and lifting has been announced by Yale & Towne Manufacturing Company, Philadelphia, Pa., in that company's new "Pul-Lift," of ¾-, 1½-, 3-, and 6-ton capacity. The device operates by means of a ratchet, which actuates a lifting sprocket. This ratchet lever has a universal action; that is, it may be operated at any point in a complete circle. The ratchet action permits of short strokes on the handle with the load supported on the brake at any point of the lifting action. Direction of hook travel is governed by a pawl, actuated on the handle grip. Both the brake and ratchet action embodied in the tool is said to facilitate close "spotting" of loads, and the self-actuating brake eliminates the possibility of flying handle. The mechanism weighs approximately 25 per cent as much as the conventional portable hoist, and is said to be ideal for riggers' equipment and operation in close quarters.

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Portable Balance Scale

A small, portable Bennett balance is announced by the Chemical Publishing Company, 175 Fifth Ave., New York. It is a sturdy, compact device weighing less than a pound and only 12 in. long. Because of its small size it can be carried in a pocket. The balance weighs up to a hundred grams and has a sensitivity of one one-hundredth of a gram. The weights are not loose, as they are component parts of the scale beam. It is said to have an alloy-steel knife edge and a highly polished agate bearing which makes for a greater sensitivity and durability.

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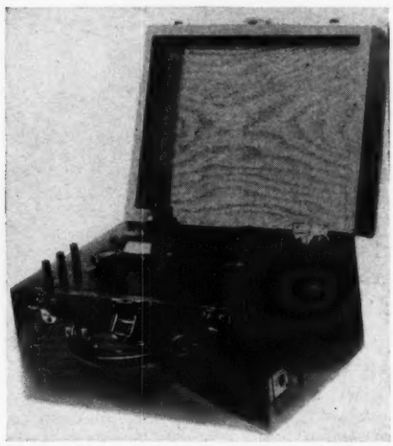
Geophysical Instrument

The Tech Laboratories, of 703 Newark Ave., Jersey City, N. J., announce a new line of geophysical instruments of interesting characteristics. These instruments have been extensively tested in Alaska and are said to be particularly well suited for the location of minerals.

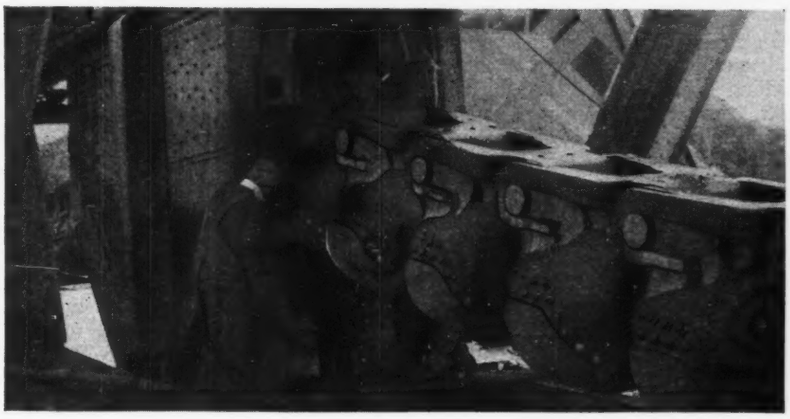
The most successful geophysical research has been carried on by the resistivity method. Type D-85 instru-



ments, here illustrated, are said to comprise a high-quality outfit of this type. In this method the effect of polarization has been entirely eliminated, and for convenience in operation there is one separate current metering outfit with battery box combined, and one potentiometer, which is light and self-contained for rapid-spot measurements. Other instruments are also available and can be made to order.

New Digging-Ladder Bucket Idler

Charles M. Romanowitz,
San Francisco, Calif.



WHILE with the Natomas Company in 1912 I was discussing with Frank R. Short, then mining engineer for that company and now consulting engineer and director of Bulolo Gold Dredging, Ltd., Placer Development, Ltd., and others, the subject of deep-digging dredges. Mr. Short was endeavoring to determine to how great a depth a dredge could be designed to dig economically. It was his opinion then that it was only a matter of proper engineering to design a dredge to dig to a depth of at least 125 ft. below water level. In his many subsequent examinations he found no property with these conditons until Bulolo, in New Guinea, was developed. Plans are now being drawn to equip this property. This, however, was not the first deposit of gold-bearing gravel that was found to be in the class of extreme deep-digging depth.

Near Hammonton, Calif., about 1916, the Marysville Dredging Company prospected an area that had this depth problem to solve. For some reason unknown to me the property was not equipped until Yuba Consolidated Gold Fields engineers later developed a large adjacent area. The engineers of the Yuba Manufacturing Company designed and rebuilt Yuba No. 17 to dig to a depth of 112 ft. below water level for exploiting the property, this unit being the first gold-placer dredge to dig over 81 ft. below water level. The description of this dredge was covered by Geo. J. Young and me in *Engineering and Mining Journal*, Nov., 1934, pp. 486-490.

Yuba No. 17 started operations on July 18, 1934, and has proved to be a success. The credit for its accomplishment undoubtedly is due to a great extent to the use of the patented Perry bucket idler on the digging ladder. Though the tin placers in the Malay districts were proved to be of the extreme depth type and the first to be equipped with successful deep-digging dredge machinery, the idler on the digging ladder was of a entirely different design. It was of the caterpillar tread type, with many wearing parts, and obviously more costly in the matter of maintenance than the Perry idler.

The idler employed on Yuba No. 17 was developed by O. B. Perry several years ago while he was interested in mining in the Malay tin areas, but he did not have an opportunity to make practical use of his invention until unit No. 17 was rebuilt. The experience on this dredge has proved the merits of this new accessory beyond expectation. Due to the fact that Yuba No. 18 was placed in operation again on March 5, 1934, with a complete new bucket line—practically at the same time as Yuba No. 17—it afforded a good opportunity to make a detailed comparison of the merits of the Perry idler with the latter dredge, Yuba No. 18, and three other units of the same size not equipped with the idler. Though Yuba No. 17 has actually dug to a depth of 112 ft. below water level, the other dredges of the same bucket capacity at Hammonton—that is, Yuba No. 18, 19, 15, and 14—all dig to a depth of about 81 ft. below water level. The record of Yuba No. 18 is similar to that of units Nos. 19, 15, and 14, so these data can be used reliably in comparing with Yuba No. 17.

The heel plates on the upper tumbler on Yuba No. 17 so far have had a life of 2 to 2.4 times those on other dredges. Bucket pins and bushings have been changed only once so far on Yuba No. 17 and have lasted 1.8 times longer than those on Yuba No. 18. The longer life of these parts is due entirely to the use of the Perry idler. This accessory causes the buckets to set squarely upon the upper tumbler, and as a consequence slippage is reduced materially because of decreased catenary pull. Slippage of the buckets on the upper tumbler has always been an irritating problem on bucket-type dredges. Recently this condition has been improved by carefully checking the increased bucket pitch and by providing thicker heel plates to compensate for the lengthening of the bucket pitch. Use of a Perry idler further improves this condition in that it lengthens the time before the heel plates have to be increased in thickness. It has also decreased bucket wear.

The idler and its connections have not caused delays or lost time to date, and the wearing plates give indication of many more months' wear. Practically no wear has been noticed on the bucket lips. Undoubtedly this is due to the fact that the designers have studied the problem carefully and have made proper provision to obviate this difficulty.

It is believed that this idler would be economical on all dredges having a digging depth of 60 ft. or more. On deep-digging dredges where the digging units are not functioning properly, it would be well to look into the application of the idler. The Yuba Manufacturing Company has the patent rights on this idler, but it is the intention to permit any manufacturer or dredge company to make use of it upon application.

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BULLETINS

The Microscope in Ore Dressing. This 24-pp. brochure by the staff of the American Cyanamid Co., 30 Rockefeller Plaza, New York City, is an unusually good example of a commercial bulletin on a technical subject. Timeliness is evidenced by the increasing use of the microscope as a tool in modern ore-dressing technique, particularly as a guide to grinding and subsequent treatment. The subject is introduced in non-technical terms for the general information of those who may be in positions of authority but not actually engaged in mill operation. This is followed by a description of the company's well-equipped metallurgical laboratory. Technical aspects of the subject are treated at length, showing what the microscope can reveal regarding the physical and chemical characteristics of minerals. Typical examinations of minerals are described and illustrated with large photomicrographs in which the various constituents are identified. Copies of this bulletin may be obtained by *E. & M. J.* readers on application to the American Cyanamid Co.

Flotation Machines. Southwestern Engineering Co., 4800 Santa Fe Ave., Los Angeles, Calif. Bulletin No. 1280, issue of 1936. An attractive pamphlet of sixteen pages featuring the Southwestern air (lift) flotation machine, including a brief foreword and history. Nine illustrations are included, many of them being photographs of actual conditions in metal mines, showing the installation of flotation equipment.

Fan and Blower Bearings. SKF Industries, Front St. and Erie Ave., Philadelphia, Pa. Pp. 7.

Air-Lift Pumps. Ingersoll-Rand Co., 11 Broadway, New York. Descriptive and illustrated bulletin, No. 9042. Pp. 19.

The Metal Cleaning Handbook. Magnus Chemical Co., Inc., Garwood, N. J. A reference and guide book for those concerned with metal cleaning.

Induction Motors. Reliance Electric & Engineering Co., Ivanhoe Road, Cleveland, Ohio. Bulletins Nos. 118 and 119. Pp. 4.

Deaerating Feedwater Heaters. Worthington Pump & Machinery Corp., Harrison, N. J. Heaters to meet power and space requirements. Bulletin W-210-B-17. Pp. 4.

Potentiometer Controllers. Foxboro Co., Foxboro, Mass. Bulletin 202, automatic controllers, intermittent-type contacts, resistance thermometer controllers. Pp. 20.

Clay Spade. Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin W-1200-B-15. Pp. 2.

Compressors. Worthington Pump & Machinery Corp., Harrison, N. J. Single-horizontal, single-stage, steam- and motor-driven 5-, 7-, 9-in. stroke. Bulletin L-611-B-5A. Pp. 7.

Air-Operated Controllers. Brown Instrument Co., Philadelphia, Pa. Catalog of air controllers for temperature, pressure, flow, and liquid level. Catalog 8900. Pp. 24.

SUMMARY OF

MONTHLY COMMENT . . . DAILY AND AVERAGE MONTHLY

SILVER overshadowed all other non-ferrous metals during the month of December. An unexpected change in purchasing policy by the Treasury that first came to light on Dec. 9, threw world trade in the metal into a state of wild confusion. Silver merchants here took the stand that the move was linked with monetary and exchange schemes that threatened to embarrass the Administration's program. Subsequent developments greatly strengthened this view. Offerings of silver that originated in the Far East became very heavy, and, with the Treasury's support withdrawn, the price declined sharply. The quotation on foreign silver in New York held at 65⅜c. up to and including Dec. 7. The month closed with the price at 49¾c. The high for 1935 was 81c., April 26.

The base metals suffered under the weakness in silver. Those who favored a higher domestic market for copper, lead, and zinc had to be content with holding quotations on an unchanged basis. Actual consumption of non-ferrous metals continued at about the peak for the year, but new buying was not up to the mark established two and three months ago.

Domestic copper continued at 9.25c., Valley. The export quotation declined a fraction of a cent. Apparent consumption of copper for the world during November was estimated at 151,900 tons, against 164,500 tons in October. United States' apparent consumption in November amounted to 51,970 tons, against 59,100 tons in the month previous. World stocks of refined copper at the end of November totaled 476,200 tons, against 496,500 tons a month previous and 591,000 tons at the beginning of 1935. Stocks of refined copper on Nov. 30 in the United States amounted to 221,000 tons, against 226,500 tons a month previous and 354,400 tons at the beginning of the year.

Lead purchases were satisfactory, and the industry believes that United States consumption of the metal has increased in recent months to at least 40,000 tons a month.

Except for the unsettlement in foreign quotations, the domestic zinc industry made further progress statistically, and the price might have advanced.

Quicksilver advanced to $76 per flask. Antimony declined three-quarters of a cent. Tin prices eased on prospects of larger supplies.

The *E.&M.J.* weighted index of metal prices for December was 75.81, against 78.08 in November. The average for 1935 was 74.66, against 69.56 in 1934.

United States Market

1935 Dec.	Electrolytic Copper—Domestic (a)	Electrolytic Copper—Export (b)	Straits Tin New York	Lead—New York	Lead—St. Louis	Zinc St. Louis
2	9.025	8.425	51.750	4.50	4.35	4.85
3	9.025	8.500	52.000	4.50	4.35	4.85
4	9.025	8.500	51.750	4.50	4.35	4.85
5	9.025	8.550	51.125	4.50	4.35	4.85
6	9.025	8.550	51.125	4.50	4.35	4.85
7	9.025	8.550	51.000	4.50	4.35	4.85
9	9.025	8.550	50.500	4.50	4.35	4.85
10	9.025	8.500	50.125	4.50	4.35	4.85
11	9.025	8.450	50.000	4.50	4.35	4.85
12	9.025	8.425	49.500	4.50	4.35	4.85
13	9.025	8.425	49.625	4.50	4.35	4.85
14	9.025	8.425	49.625	4.50	4.35	4.85
16	9.025	8.375	49.850	4.50	4.35	4.85
17	9.025	8.325	49.850	4.50	4.35	4.85
18	9.025	8.350	49.750	4.50	4.35	4.85
19	9.025	8.225	49.250	4.50	4.35	4.85
20	9.025	8.300	49.000	4.50	4.35	4.85
21	9.025	8.325	49.000	4.50	4.35	4.85
23	9.025	8.350	48.750	4.50	4.35	4.85
24	9.025	8.375	48.625	4.50	4.35	4.85
25	Holiday					
26	9.025	8.375	48.375	4.50	4.35	4.85
27	9.025	8.375	48.500	4.50	4.35	4.85
28	9.025	8.375	48.550	4.50	4.35	4.85
30	9.025	8.375	48.600	4.50	4.35	4.85
31	9.025	8.375	48.625	4.50	4.35	4.85
Av. for month	9.025	8.414	49.794	4.50	4.35	4.85
Averages for Week						
4	9.025	8.438	51.625	4.50	4.35	4.85
11	9.025	8.525	50.646	4.50	4.35	4.85
18	9.025	8.388	49.700	4.50	4.35	4.85
25	9.025	8.315	48.925	4.50	4.35	4.85
Calendar Week Averages						
7	9.025	8.513	51.458	4.50	4.35	4.85
14	9.025	8.463	49.896	4.50	4.35	4.85
21	9.025	8.317	49.450	4.50	4.35	4.85
28	9.025	8.370	48.560	4.50	4.35	4.85

Silver, Gold, and Sterling Exchange New York and London

1935 Dec.	Sterling Exchange—"Checks"	Sterling Exchange—"90-day" Demand"	Silver (c)—New York	Silver (c)—London	Gold—London	Gold (d) United States
2	4.92875	4.91750	65.375	29.2500	141s	$35.00
3	4.92750	4.91625	65.375	29.2500	141s 1 d	35.00
4	4.93125	4.92000	65.375	29.1875	140s 11½d	35.00
5	4.93125	4.92000	65.375	29.1875	140s 11½d	35.00
6	4.92500	4.91125	65.375	29.1875	141s	35.00
7	4.92625	4.91500	65.375	29.1875	141s 1d	35.00
9	4.92500	4.91375	64.750	28.7500	141s ½d	35.00
10	4.92875	4.91750	63.750	No Quotation	141s	35.00
11	4.92500	4.91375	62.750	27.5000	141s 2½d	35.00
12	4.92125	4.91000	61.750	26.8750	141s 2 d	35.00
13	4.92625	4.91500	60.750	26.4375	141s 1 d	35.00
14	4.92750	4.91750	No Quotation	Nominal 26.4375	141s 1 d	35.00
16	4.92500	4.91500	59.750	26.0000	141s 1½d	35.00
17	4.92750	4.91750	58.750	24.8750	141s 1½d	35.00
18	4.92500	4.91500	55.750	23.0000	141s 3 d	35.00
19	4.92250	4.91375	53.750	22.1875	141s 1 d	35.00
20	4.92750	4.91625	51.750	21.7500	141s 1½d	35.00
21	4.92875	4.91750	No Quotation	No Quotation	141s ½d	35.00
23	4.92625	4.91375	50.750	21.3125	141s 1 d	35.00
24	4.92625	4.91375	49.750	20.8750	141s 1 d	35.00
25	Holiday				141s 1 d	Holiday
26	4.92750	4.91500	49.750	Holiday		35.00
27	4.92750	4.91500	49.750	21.0000	141s	35.00
28	4.93500	4.92250	No Quotation	No Quotation	140s 11 d	35.00
30	4.92750	4.91500	49.750	22.0625	141s 3 d	35.00
31	4.92875	4.91750	49.750	22.5000	141s 2 d	35.00
Av. for month	4.92715	.....	58.420	25.563	.....	35.00
Averages for Week						
4	4.93000	.....	65.375	.....	.....	.....
11	4.92688	.....	64.563	.....	.....	.....
18	4.92542	.....	59.350	.....	.....	.....
25	4.92625	.....	51.500	.....	.....	.....

Calendar week averages: New York Silver Dec. 7th, 65.375; 14th, 62.750; 21st 55.950; 28th, 50.000.

The above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and interest charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.300c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High-Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order issued April 24, 1935, the U. S. Government's price on newly mined domestic silver was established at 77.57.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

THE MARKETS

PRICES OF METALS . . . MISCELLANEOUS QUOTATIONS

London Market

Dec	Copper Standard Spot	Copper Standard 3M	Copper Electrolytic Bid	Tin Standard Spot	Tin Standard 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
2	35.5625	35.9375	39.5000	223.0000	213.0000	17.6250	17.6250	15.6875	16.0000
3	35.4375	35.8750	39.5000	224.5000	213.2500	17.7500	17.7500	15.6250	15.9375
4	35.5625	36.0000	39.7500	224.2500	213.5000	17.7500	17.7500	15.7500	16.0625
5	35.6875	36.0625	40.0000	222.0000	211.0000	17.5625	17.5625	15.6250	15.9375
6	35.5625	36.0000	40.0000	222.7500	212.0000	17.3750	17.3750	15.4375	15.8125
9	35.8750	36.3125	40.2500	221.0000	210.5000	17.5625	17.5625	15.6250	15.9375
10	35.5000	35.8750	39.7500	219.7500	209.5000	17.2500	17.2500	15.4375	15.7500
11	35.1250	35.5000	39.2500	219.0000	208.2500	16.8750	16.9375	15.1250	15.3750
12	35.0000	35.5000	39.2500	218.5000	208.7500	16.9375	17.0000	15.1250	15.3125
13	35.0625	35.5000	39.0000	219.5000	208.7500	16.8750	16.8750	15.0625	15.3125
16	34.8125	35.1875	39.0000	221.0000	209.7500	16.6875	16.6875	14.8750	15.0625
17	34.3750	34.8125	38.5000	221.0000	211.0000	16.7500	16.7500	14.8750	15.0000
18	34.6875	35.1250	39.0000	220.7500	210.6250	16.7500	16.7500	14.9375	15.0625
19	34.3125	34.7500	38.5000	219.7500	299.7500	16.5625	16.5625	14.7500	14.8750
20	34.5625	35.0000	39.0000	218.5000	209.0000	16.5625	16.5625	14.8750	14.9375
23	34.8125	35.2500	39.0000	216.7500	208.5000	16.1250	16.1875	14.6875	14.7500
24	35.0000	35.4375	39.2500	216.2500	207.7500	16.1250	16.1875	14.6875	14.7500
25					Holiday				
26					Holiday				
27	35.0625	35.4375	39.2500	217.5000	208.2500	15.8750	15.9375	14.6250	14.6875
30	34.9375	35.3750	39.2500	217.7500	208.0000	15.4375	15.5000	14.4375	14.4375
31	35.0000	35.4375	39.2500	218.0000	208.0000	15.6250	15.7500	14.5625	14.5625
Av. for month	35.097	.....	39.313	220.075	.....	16.803	16.828	15.091	15.278

Current Prices—Miscellaneous Metals, Ores, and Non-Metallic Minerals

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated.

(January 2, 1936)

Miscellaneous Metals

Aluminum, ingot, 99 per cent plus, lb.	19@21c.
Antimony, domestic or Chinese (duty paid), lb.	13.25c.
Bismuth, ton lots, lb.	$1.00
Cadmium, lb.	$1.05
Chromium, 97 per cent grade, lb.	88c.
Nickel, electrolytic cathodes, lb.	35c.
Magnesium, 99.8 per cent, carloads, lb.	30c.
Palladium, troy oz.	$24.00
Platinum, (official quotation) troy oz.	$38.00
Quicksilver, flask of 76 lb., 100 flasks or more	**$76.00**
Radium, mg. radium content	$50.00
Selenium, 99.5 per cent, lb.	$2.00
Silicon, minimum 97 per cent, spot, lb.	16.50c.
Tellurium, lb.	$2.00
Thallium, 100 lb. or more, lb.	$6.50
Titanium, 96 to 98 per cent, lb.	$6.00
Zirconium, commercially pure, lb.	$7.00

Metallic Ores

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 45@47 per cent, c.i.f., long ton	$16.00@$16.50
Iron Ore, Lake Superior, long ton:	
Old Range bessemer	$4.80
Mesabi bessemer	$4.65
Old Range, non-bessemer	$4.65
Mesabi, non-bessemer	$4.50
Lead (Galena) 80 per cent, Joplin, Mo., ton	$47.00
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52@55 per cent	26c.
49@51 per cent	25c.
44@47 per cent	24c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	42c.
Tungsten Ore, per unit of WO_3:	
Chinese duty paid	$15.75@$16.00
Domestic Scheelite	$15.50@$15.75
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton.	$32.00

Metallic Compounds

Arsenious Oxide (arsenic) lb.	3½c
Cobalt Oxide, 70@71 per cent, lb.	$1.39@$1.49
Copper Sulphate, 100 lb.	$3.85
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb.	$1.24
Sodium Sulphate, bulk, ton	$13.00@$15.00

Alloys

Beryllium-Copper, Master alloy, 3.5 per cent Be, per lb. of contained Be	$30.00
Ferrochrome, 65@70 per cent chromium, 4@6 per cent carbon, lb.	10c.
Ferromanganese, 78@82 per cent, gross ton	$75.00
Ferromolybdenum, 50@60 per cent Mo, lb. of Mo contained.	95c.
Ferrosilicon, 50 per cent, gross ton	$77.50
Ferrotungsten, 75@80 per cent, lb. of W contained	$1.30@$1.40

Non-Metallic Minerals

Asbestos, f.o.b. mines ton:	
Canadian (Quebec)	
Crude No. 1	$500@.....
Crude No. 2	$200@$225
Spinning fibers	$90@$135
Paper stock	$32.50@$37.50
Shorts	$11@$14.50
Vermont	
Shingle stock	$47@.....
Paper stock	$35@.....
Cement stock	$23@.....
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 95 per cent $BaSO_4$, less than 1 per cent iron	$5.50
Bauxite, long ton:	
Domestic, chemical, 55@58 per cent	$6@ $7.50
Domestic, abrasive, 78@84 per cent	$12.50@$15.00
Dalmatian, 50@55 per cent	(a) $4.50@ $6.00
French, 56@59 per cent	(a) $5.50@ $6.50
China Clay, f.o.b. mines ton:	
South Carolina and Georgia, bulk	$7.00@ $9.00
Delaware, No. 1	$14.00@.....
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85-5 per cent, all rail movement, ton	$16.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00@.....
Dead-burned, f.o.b. Washington	$22.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½x2 in.	15@30c.
2x2 in.	30@50c.
2x3 in.	50@65c.
3x4 in.	90@ $1.25
4x6 in.	$1.50@ $2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.50
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12@ 12½c.
Silica, water-floated, in bags, 325 mesh, ton	$16.00@$40.00
Sulphur, Texas mines, long ton	$18.00@.....
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$8.50@ $9.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$15.00@.....
200 mesh, cream colored	$25.00@.....

(a) Nominal.

Iron and Steel

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$20.00
Basic	$19.00
No. 2 Foundry	$19.50
Steel, base prices, Pittsburgh:	
Billets, gross ton	$20.00
Structural shapes, 100 lb.	$1.80
Bars, 100 lb.	$1.85

MONTHLY AND YEARLY AVERAGE PRICES

Silver and Sterling Exchange

	Silver, New York		Silver, London Spot		Sterling Exchange "Checks"	
	1934	1935	1934	1935	1934	1935
January	44.188	54.418	19.382	24.584	504.644	489.207
February	45.233	54.602	20.073	24.818	503.085	487.278
March	45.875	59.048	20.278	27.380	509.259	477.635
April	45.180	67.788	19.740	30.986	515.210	483.596
May	44.226	74.356	19.276	33.865	510.510	488.587
June	45.173	71.940	19.981	32.346	504.721	493.245
July	46.310	68.216	20.512	30.500	503.990	495.558
August	48.986	66.366	21.377	29.476	506.398	496.815
September	49.484	65.375	21.888	29.255	499.344	492.917
October	52.375	65.375	23.581	29.368	494.019	490.577
November	54.255	65.375	24.257	29.284	498.832	492.277
December	54.390	58.420	24.404	25.563	494.520	492.715
Year	47.973	64.273	21.229	28.952	503.711	490.034

New York quotations for silver not eligible for sale to U. S. Government, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery, Electrolytic, Domestic		F.O.B. Refinery, Electrolytic, Export	London Spot, Standard		London Spot, (a) Electrolytic	
	1934	1935	1935	1934	1935	1934	1935
January	7.890	8.775	6.583	32.560	28.077	35.614	31.261
February	7.777	8.775	6.341	33.072	27.175	35.969	30.244
March	7.775	8.775	6.526	32.497	28.518	35.512	31.607
April	8.173	8.775	7.328	33.006	31.231	36.038	34.763
May	8.275	8.775	7.794	32.662	33.344	35.756	36.733
June	8.594	8.634	7.307	32.149	30.799	35.339	34.039
July	8.775	7.775	7.350	29.707	31.024	32.778	34.261
August	8.775	7.979	7.738	28.358	32.646	31.483	35.976
September	8.775	8.504	8.146	27.541	34.036	30.556	37.952
October	8.775	8.967	8.514	26.753	35.226	29.478	39.609
November	8.775	9.025	8.414	27.233	35.229	30.222	39.396
December	8.775	9.025	8.414	27.836	35.097	31.086	39.313
Year	8.428	8.649	7.538	30.281	31.867	33.319	35.430

New York quotations, cents per pound. London, pounds sterling per long ton. (a) Bid quotation.

Lead

	New York		St. Louis		London			
	1934	1935	1934	1935	1934 Spot	1934 3 Mos.	1935 Spot	1935 3 Mos.
January	4.000	3.692	3.900	3.542	11.304	11.517	10.321	10.514
February	4.000	3.528	3.900	3.378	11.634	11.913	10.216	10.413
March	4.000	3.579	3.900	3.429	11.545	11.842	11.012	11.188
April	4.179	3.692	4.042	3.542	11.500	11.794	12.231	12.459
May	4.140	3.962	3.990	3.812	11.051	11.341	13.861	13.940
June	3.975	4.020	3.825	3.870	11.054	11.253	13.776	13.806
July	3.772	4.123	3.623	3.973	10.813	11.045	14.451	14.511
August	3.747	4.254	3.597	4.104	10.821	11.028	15.774	15.792
September	3.685	4.413	3.535	4.263	10.388	10.613	16.262	16.315
October	3.654	4.512	3.504	4.362	10.359	10.554	18.209	18.209
November	3.567	4.500	3.417	4.350	10.432	10.597	17.938	17.935
December	3.604	4.500	3.454	4.350	10.316	10.500	16.803	16.828
Year	3.860	4.065	3.724	3.915	10.935	11.166	14.238	14.326

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	Straits, New York		Standard, Spot, London	
	1934	1935	1934	1935
January	51.891	50.916	226.631	231.193
February	51.668	50.063	226.731	227.381
March	53.838	46.962	233.863	215.726
April	55.622	50.154	239.181	223.513
May	53.541	51.138	234.239	227.602
June	51.271	51.108	226.875	227 586
July	51.930	52.297	230.381	232.397
August	51.953	50.463	228.114	222.935
September	51.503	49.126	229.888	223.929
October	50.951	51.160	230.587	226.891
November	51.227	51.864	228.602	226.452
December	50.902	49.794	228.178	220.075
Year	52.191	50.420	230.273	225.473

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1934	1935	1934 Spot	1934 3 Mos.	1935 Spot	1935 3 Mos.
January	4.271	3.730	14.688	14.943	11.994	12.207
February	4.384	3.714	14.844	15.125	11.819	12.000
March	4.368	3.894	14.735	15.033	12.095	12.250
April	4.370	4.030	14.916	15.200	12.891	13.128
May	4.346	4.220	14.722	14.966	14.534	14.685
June	4.240	4.299	14.241	14.467	13.734	13.898
July	4.317	4.325	13.466	13.693	14.065	14.185
August	4.281	4.535	13.682	13.756	14.714	14.938
September	4.049	4.669	12.644	12.847	15.414	15.616
October	3.832	4.825	12.217	12.353	16.440	16.674
November	3.732	4.850	12.000	12.281	16.193	16.372
December	3.711	4.850	11.730	12.016	15.091	15.278
Year	4.158	4.328	13.657	13.890	14.082	14.269

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium		Aluminum	
	1934	1935	(a) 1934	(b) 1935
January	55.000	55.000	23.300	20.000
February	55.000	55.000	23.300	20.000
March	55.000	58.462	23.300	20.000
April	55.000	65.000	23.300	20.000
May	55.000	65.000	23.300	20.000
June	55.000	65.000	23.300	20.000
July	55.000	65.000	23.300	20.000
August	55.000	70.000	23.300	20.000
September	55.000	75.625	23.300	20.000
October	55.000	85.000	23.300	20.000
November	55.000	85.000	23.300	20.000
December	55.000	101.800	23.300	20.000
Year	55.000	70.491	23.300	20.000

Aluminum in cents per pound, 99 per cent grade. (a) Based on Aluminum Company's quotation. (b) Open market price.
Cadmium, cents per pound.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1934	1935	1934	1935	1934	1935
January	7.198	14.111	67.538	72.760	38.000	34.000
February	7.172	14.250	72.011	72.500	38.000	34.000
March	7.545	14.250	75.472	72.500	38.000	32.846
April	7.918	14.029	75.930	72.500	38.000	32.000
May	8.465	12.712	75.577	72.135	36.538	32.000
June	7.900	12.500	75.000	71.460	36.000	32.000
July	8.024	12.500	75.000	70.538	36.000	32.000
August	8.514	12.500	75.000	69.000	36.000	31.333
September	8.745	13.177	74.563	69.208	36.000	36.000
October	9.361	15.322	74.000	71.750	35.038	37.615
November	12.239	14.217	73.283	74.348	35.000	38.000
December	13.730	13.820	73.000	75.200	35.000	38.000
Year	8.901	13.616	73.865	71.992	36.465	34.150

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

Pig Iron

	Bessemer		Basic		No. 2 Foundry	
	1934	1935	1934	1935	1934	1935
January	18.00	19.00	17.00	18.00	17.50	18.50
February	18.00	19.00	17.00	18.00	17.50	18.50
March	18.00	19.00	17.00	18.00	17.50	18.50
April	18.48	19.00	17.48	18.00	17.98	18.50
May	19.00	19.00	18.00	18.00	18.50	18.50
June	19.00	19.00	18.00	18.00	18.50	18.50
July	19.00	19.00	18.00	18.00	19.50	18.50
August	19.00	19.00	18.00	18.00	18.50	18.50
September	19.00	19.00	18.00	18.00	18.50	18.50
October	19.00	19.00	18.00	18.00	18.50	18.50
November	19.00	20.00	18.00	19.00	18.50	19.50
December	19.00	20.00	18.00	19.00	18.50	19.50
Year	18.707	19.167	17.707	18.167	18.207	18.667

Iron in dollars per long ton. F.o.b. Mahoning and Shenango Valley furnaces.